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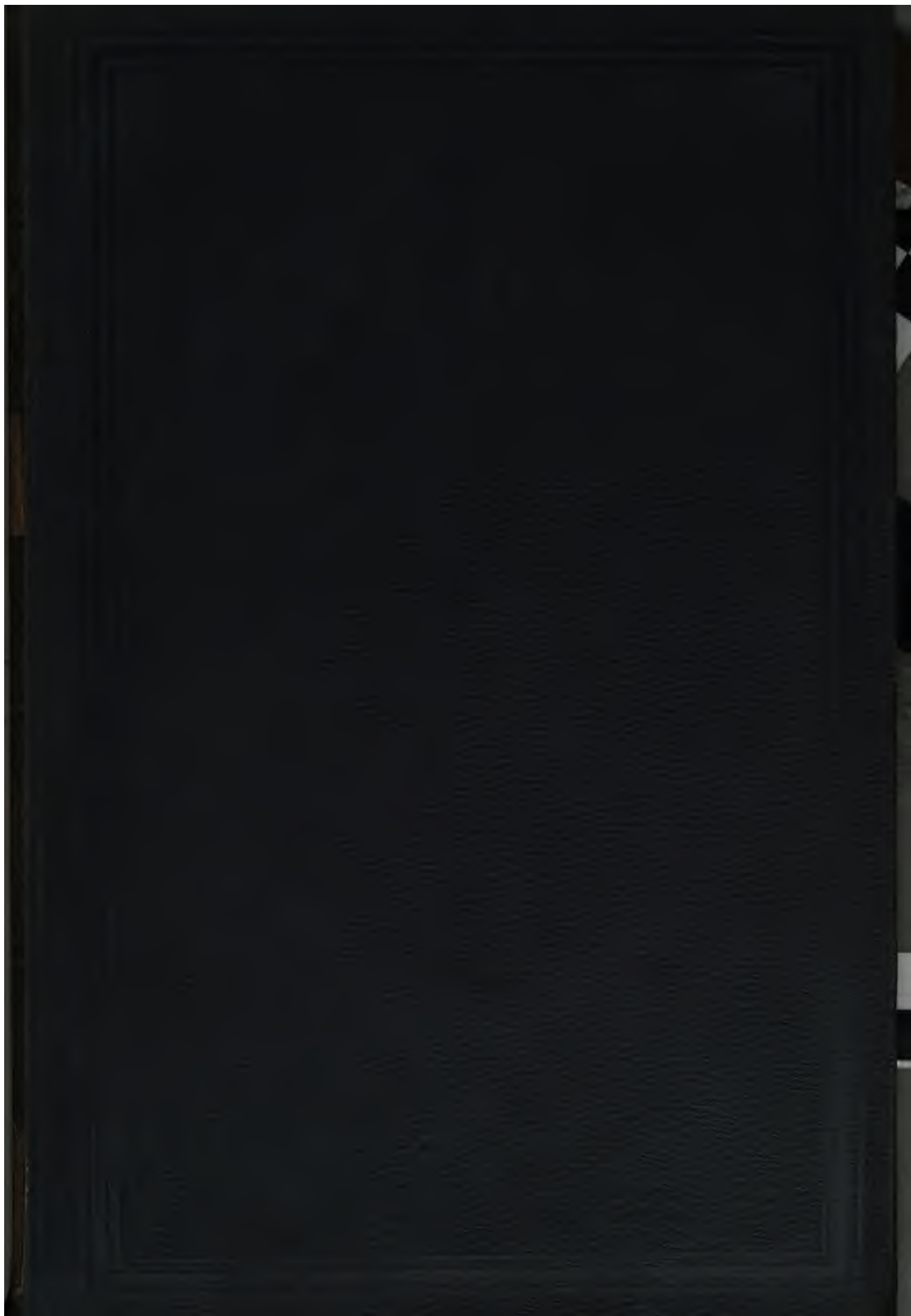
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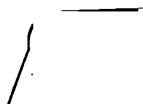




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THE
SCREW-FLEET OF THE NAVY.

Dedicated, by Permission,

TO THE RIGHT HON.

SIR F. T. BARING, BART, M.P.,

FIRST LORD OF THE ADMIRALTY.

BY

E. P. HALSTED, Esq., CAPT. R.N.

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TO

THE RIGHT HON. SIR FRANCIS T. BARING, BART., M.P.,

&c. &c. &c.

FIRST LORD OF THE ADMIRALTY.

SIR,

IN submitting with grateful acknowledgment the pages to which I am allowed the honour of prefixing your name, may I be permitted very briefly to state the means and the motives which I have had for writing them?

The subject they treat of first received my attention while commanding H.M.S. "Childers," when the "Archimedes" made the first maritime voyage ever performed by the Screw, and appeared at Portsmouth, in May, 1839, at the launch of H.M.S. "Queen." I then found Mr. Francis Pettit Smith, the practical Inventor of Screw-propulsion, to be fully alive to its peculiar adaptation for the Navy. The absence of all impediment to the traditional full-armed broadside;—the ship herself a fully furnished and independent sailing-ship;—the economy of using Sail-power, or Steam-power, at option;—the employment of machinery entirely protected from shot. These were all clearly explained to me to constitute the merits of his Invention for Ships-of-War, dependent of course upon the competent propelling powers which the instrument itself might possess.

On returning from India in 1843, I renewed my attention to

the subject, which the Admiralty by that time had taken in hand. The River performance of the "Rattler," in 1843 and 1844, gave fresh hopes of success; and led to that course of practical trials which was ordered to be made in the North Sea between H.M. Ships "Rattler" and "Alecto" in the spring of 1845, and at which I attended. These trials confirmed the equal propelling power of the Screw and Paddle-wheel at Sea; and the conviction of this result on the minds of the Admiralty caused their Lordships to lay the foundation of our present SCREW FLEET, by ordering the construction of 'Screw ships,' and conversion of 'Auxiliaries,' to the extent of twenty-three vessels, towards the autumn of that year.

From this date I have considered the subject, in all its bearings, worthy of an undivided attention; and on closing a course of two years' study on board H.M.S. "Excellent," and at the Royal Naval College at Portsmouth, I removed in the summer of 1846 to Woolwich, and for a further period of fifteen months, then and since, have been an attendant at almost every experiment or trial, there or elsewhere, which could furnish any practical knowledge of the Principle or its details.

I need scarcely observe how such a course of observation has also included the privilege of frequent intercourse with the several leading minds so earnestly directed to the same subject.

During the winter of 1847-8 I was engaged to supervise the completion of machinery for H.M.S. "Dauntless," and the construction of H.M. Ships "Simoom" and "Greenock," in the Clyde;—with instructions to submit to their Lordships such suggestions as might tend to develop the powers of these ships,

in both their steaming and sailing capacities. And in the summer of the latter year I attended all the preliminary trials of the first-named of these ships, and accompanied her from the Clyde to Portsmouth, with the view to notice her qualities.

I may here express my sense of the confidence with which yourself, Sir, and their Lordships were pleased to appoint me, in concert with Captain Austin, C.B., to conduct the course of trials between H.M. Ships "Basilisk" and "Niger," which occupied the summer of last year.

I advert to these personal matters solely that they may be permitted to account for whatever may seem unusual in the form in which I have the honour to submit the subject-matter of these pages. Because it is this long and connected experience which has taught me to believe, that the progress of Screw-propulsion, in connexion with the Navy, may be assisted in its present stage by a careful re-exposition of its Principles; far more than by any mere record of its success. This experience has enabled me to trace, how the time which has elapsed, and how the changes which have occurred, since first a Screw Fleet was laid down, have contributed to efface the distinct nature of those advantages which the Screw was intended to secure. It has led me to observe how the doubts which have been raised by allegations against the speed of the Screw, have disturbed our attention from the more solid merits of FULL BROADSIDES, and FULL SAIL-POWERS, which were the special Objects of its adoption. And it has convinced me that a strict care in providing for the complete attainment of these special Objects is our true safeguard against the error of mistaking a Screw for some modification of a Paddle-wheel—an error which is sure to lead to some common mode

of providing for the operation of two distinct Mechanical Principles, and which therefore can only tend to embarrass that satisfactory progress which their Lordships are so anxiously endeavouring to pursue.

It is for these reasons that I have been desirous to adopt the most serviceable form in which I might present the details of this experience. And therefore I have decided, First;—to define the distinctive advantages which the Screw was always intended to secure. Next;—to illustrate its perfect ability to realize these advantages when duly provided for. Lastly;—to prove that these advantages are alone consistent with the Principle of Screw-propulsion itself, or with the extent to which we have adopted it in the Navy.

By this mode of treating the subject I have allowed myself to hope that I might strengthen that steady Confidence which is so essential in conducting a comprehensive System of progress with success. And in thus seeking to promote confidence in a Principle, which was adopted with the view to stamp upon our whole Fleet a character of marked improvement, it has been my wish to show an earnestness in some degree commensurate with the great responsibility of working out such an undertaking—but an earnestness which cannot outweigh the true respect with which

I have the honour to be,

Sir,

Your obliged and obedient servant,

EDWARD PELLEW HALSTED.

PREFATORY NOTICE.

IN the following pages I have hoped to make it appear that I am not urging the introduction of any new and specious Invention; but that I have written them with the sole view to assist to its appointed end, an Invention very extensively adopted long before they were commenced; and which has seemed not unworthy of such assistance as it might receive from them.

I have written under a conviction that we are living in purely TRANSITION-TIMES; when new Powers are being placed in our hands at once for the fulfilment of past purposes, and the development of those which are new. And that with these Powers is given us no alternative but to use them. Those who do so, whether nationally or associately, soonest and most consistently, will be the first to reap the advantages they are destined to confer. And as we have launched the boldest on this course of Naval advancement, so we may be the first to reap the improvements it leads to;—IF WE KEEP THOSE IMPROVEMENTS STEADILY IN VIEW.

I am quite aware that these pages may give rise to controversy, for I have not known how to write them so as to avoid its risk; if I had I would have done so. But they have not been written for any such purpose; neither will they be defended by me from any mere controversial attack. They

treat of a subject yet young, though of very great importance, and which is yet in progress as I write about it.—A subject which very deeply affects very extensive interests, besides those of the Navy; and which has naturally excited hitherto far more jealousy than favour. I therefore forestall the charges sure to be made against them; by candidly admitting that they do no doubt, notwithstanding every care, contain a full share of errors. Errors of fact;—errors of figure;—errors of information from others;—errors of observation of my own. Still I charge it upon the more impartial judgment of critics to say, whether every point of importance which they illustrate, has not been supported by such an amount of substantial truth, as to leave that point unimpaired; and to prove that all error has been involuntary.

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CHAPTER I.

ON FULL-POWERED SCREW-SHIPS.

PART I.

THE SCREW-SHIP ALWAYS INTENDED TO BE A PERFECT SAILING-SHIP PROVIDED WITH A FULL-ARMED BROADSIDE.

At a time when some diversity of opinion appears to exist as to the best plan for eliciting the value of our Full-powered Screw ships, it may perhaps assist towards a satisfactory decision, to re-state the objects originally contemplated by the introduction of the principle of Propulsion they are intended to develop; with the view, subsequently, to trace how far we are in course of realizing the objects; or how far, whether from necessity or otherwise, they may have been deviated from, or lost sight of, during the lengthened period required for the completion of the Ships.

The chief motive, then, which determined the adoption of the SCREW for the War-steamers of the Navy, was to secure the extensive advantages it offered under the two important Heads of EFFICIENCY and ECONOMY.

The intended advantages of adopting the principle of Screw-propulsion in the Navy.

As regards superior Efficiency.—The Objects to be obtained were two.

The first was;—‘ TO RESTORE THAT COMPLETE BROADSIDE ARMAMENT, WHICH EXPERIENCE HAD EVER SHOWN, TO BE THE BEST ADAPTED FOR ALL THE EXIGENCIES OF WARFARE.’

The second was;—‘ TO RENDER THIS COMPLETE ARMAMENT AT ALL TIMES AVAILABLE; AND TO SECURE FOR THE SHIP THE FULL CO-OPERATION OF STEAM-POWER, WHETHER IN CLOSE OR DISTANT ACTION, BY SO DISPOSING HER MA-

**‘CHINERY AS TO AFFORD IT A PROTECTION AS EFFECTUAL AS
‘THAT OF THE MAGAZINE ITSELF.’**

As regards superior Economy.—This Object was to be obtained by the use of the same means which we had always been attempting to employ for the same purpose in the Paddle-steamer. That is; the Full-powered Screw-ship was to be equipped and worked as a Perfect Sailing-ship also; and the modes of employing the Full Sail-power to be supplied for the purpose of thus working her were two.

The first was;—**‘THAT ALL GENERAL SERVICE SHOULD BE
‘EFFECTIVELY PERFORMED UNDER SAIL ALONE.’**

The second was;—**‘THAT ALL SPECIAL SERVICE SHOULD
‘BE EFFECTIVELY PERFORMED BY AIDING THE FULL SAIL-
‘POWER WITH A LIMITED USE OF THE STEAM.’**

The employment of the FULL STEAM-POWER, either combined or not combined with the sails, as each case might require, would thus be reserved for the performance of **‘EXCEPTIONAL SERVICES’** alone. And the period of its use would be limited to the bare duration of each case requiring it, by reverting to the employment of either Sail-power, or Auxiliary Steam-power, as soon as the demand for Full Steam-power ceased.

Directly connected with this intended equipment with a full spread of canvas, two other advantages of high importance were seen at the same time to be attained.

The first was;—**‘That this Full Sail-power would render
‘available the Services of the Screw-ship as a complete man-
‘of-war at all times, independent of accidents to machinery,
‘or difficulties in obtaining a supply of fuel.’**

The second was;—**‘That the constant use of this Full Sail-
‘power would relieve the Screw-ship from the defect of the
‘Paddle-steamer; and would give her a position in the Navy as
‘an efficient school of discipline and instruction for men and
‘officers, IN PRACTICAL SEAMANSHIP.’**

Now in thus re-stating the Objects which were originally

intended to be obtained by the substitution of the Screw for the Paddle in the Steam-fleet of the Navy, it will be seen that all reference to the question of improved speed has been omitted; and for this intentional omission I would wish it to be observed that there are these two reasons. First;—because the Screw did not hold out the prospect of such superiority in this important particular, as could justify for its sake alone, so extensive a change, in so costly an arm of the national power as our Steam Navy. And next;—because so pre-eminent were held to be the advantages I have specified, that had it been necessary to purchase them at the sacrifice of some per centage of speed, such price would at once have been cheerfully paid. I must not, however, be supposed to mean that the importance of high speed in every War-steamer, was then more than now, either under-estimated or overlooked. Still less can I admit that any sacrifice of it has in anywise been made. The then matured conviction,—based upon our earliest and continued experience,—that the one Instrument would prove in this respect as effective as the other, has been amply verified by results. And in addition to this it was early and clearly seen, that the restoration of a complete armament to the broadside would relieve the extremities of the Ship from the great weight of guns which the necessities of the Paddle had caused to be placed there, and which operated as the great impediment to high speed in every armed Steamer. The Constructor would thenceforth be left entirely free to adopt those finer lines of ‘entrance’ and ‘run,’ from which he had been hitherto debarred by the necessity of providing for the support of heavy armament in the extreme ends of his ships. By this ability to improve his Forms, he would be in a position to provide for increased speed, perhaps even with reduced power. And therefore the adoption of the Screw when it provided for the removal of the chief impediment by which the Constructor had hitherto been shackled,

Improvement
of Speed, ex-
pected only as
the conse-
quence of im-
provement of
Form.

did in fact provide also for obtaining improved speed, with superior efficiency and economy combined.*

* As this statement of the equal Speed of the Screw and the Paddle is one which may not meet with general acceptance, and may therefore need support, I will request notice to the following List of the Light and Load-water speeds, of the "Rattler," and of certain armed Paddle-steamers, of the "Rattler's" power and upwards; as ascertained by trials made before the 'measured mile' in Long Reach, and recorded at the Steam Factory at Woolwich. The equality established by these results obtained in the River, being fully confirmed by the trials of the "Rattler" with the "Alecto," the "Vesuvius," and the "Polyphemus" at sea. It will be seen that the "Rattler's" load speed exceeds the mean of the fifteen other load speeds quoted by 12·5 per cent., notwithstanding her smaller proportion of Power to tonnage.

REGISTERED SPEED IN KNOTS OF HER MAJESTY'S ARMED STEAMERS, AS ASCERTAINED BEFORE THE "MEASURED MILE."

| Name. | Tonnage. | Nominal Power. | Proportion of Tons per Horse Power. | At Load Draught. | At Light Draught. | As ascertained otherwise. |
|----------------|----------|----------------|-------------------------------------|------------------|-------------------|-------------------------------|
| Alecto . . . | 800 | 200 | 4 | 7·698 | .. | |
| Ardent . . . | 801 | 200 | 4 | 8·947 | .. | |
| Polyphemus . . | 801 | 200 | 4 | 7·977 | .. | |
| Prometheus* . | 796 | 200 | 4 | 8·75 | .. | |
| Medea . . . | 835 | 220 | 3·8 | 8·471 | .. | |
| Hydra. . . . | 818 | 220 | 3·7 | 9·251 | .. | |
| Phoenix . . . | 809 | 220 | 3·7 | 7·810 | .. | |
| Styx | 1059 | 280 | 3·7 | 8· | .. | |
| Driver | 1056 | 280 | 3·7 | 8·495 | .. | |
| Geyser | 1054 | 280 | 3·7 | 8·406 | .. | |
| Vixen | 1054 | 280 | 3·7 | 7·263 | .. | |
| Cyclops . . . | 1190 | 320 | 3·7 | 9·124 | .. | |
| Eclair | 1059 | 296 | 3·6 | 9·557 | .. | |
| Cormorant . . | 1057 | 300 | 3·5 | 9·112 | .. | |
| Vesuvius . . . | 970 | 280 | 3·4 | 9·540 | .. | |
| Gorgon | 1111 | 320 | 3·4 | .. | 9·646 | |
| Stromboli . . | 967 | 280 | 3·4 | .. | 10·067 | |
| Firebrand . . | 1190 | 410 | 2·9 | .. | 10·163 | |
| Gladiator . . | 1190 | 430 | 2·7 | .. | .. | 12·5, by Massey's log, light. |
| Devastation . | 1058 | 400 | 2·6 | .. | 10·002 | |
| Vulture . . . | 1191 | 470 | 2·5 | .. | 10·545 | |
| Terrible . . . | 1847 | 800 | 2·3 | .. | .. | 10·9 by Massey's log. |
| Ball-dog . . . | 1194 | 500 | 2·2 | .. | .. | 10·4 by log, with jib set. |
| Retribution . | 1641 | 800 | 2· | .. | .. | 12 stated, when light. |
| "Rattler" . . | 888 | 200 | 4·4 | 9·638† | 10·074‡ | |

* The "Prometheus" had tubular boilers, and the weights on her safety-valves were reduced to 5 lbs. per square inch, to enable the "Rattler" to contend with her more fairly.

† Loaded and rigged.

‡ Loaded, but not rigged.

It was, however, with respect to the armament that the most important advantages were intended to be obtained; and so was it foreseen that to realize these advantages the greatest difficulties would have to be met.

Full-armed broadsides, the chief object as regards increased Efficiency.

It is true that at little expense or difficulty the change alone in the mode of propulsion, would at once disencumber the decks of the Screw-ship;—relieve her of a vast weight of top hamper both in hull and machinery;—and remove from her sides the incumbrances inseparable from the very nature of the Paddle-wheel. It also at once provided the means of restoring the battery to its accustomed power and completeness, and replaced it in that legitimate position in the broadside, out of which,—not by choice, but of necessity,—not with improvement, but in every respect with loss,—it had by the Paddle-wheel been driven. Nor was it of small advantage that thus was a satisfactory solution seen at once, of all those perplexities, plans, and projects, which for years had occupied the earnest yet futile endeavours of all concerned, to give to the Paddle-steamer the character of a powerfully and effectively armed ship. It was also no small triumph that in making this change in the Instrument of propulsion it was in no way necessary to change the engines, or the various plans of engines by which it could be driven; since, with but unimportant adaptations and additions of detail, the ‘double cylinder-engines of the “Rattler,” and the ‘oscillating cylinder’ engines of the “Phoenix,” were found to do their work with perfect efficiency; and so also without material change in form or principle, every other Marine engine which had hitherto been perfected for the Paddle, might, *as far as regarded the instrument itself*, with equal effect be made to apply its effort to the Screw. All these were points of undeniable importance which were secured at once by the mere act of accepting the change proposed, and that without any serious cost of labour or expense.

The necessity for a new system of machinery, in order to render the broadside completely effective.

But this change was both proposed and accepted with the intention that the armament of our future Steam Fleet should be rendered by its means completely effective no less than powerful, and the limited instances in which as yet the Steamer had been engaged in action had sufficed to establish the fact, that, however powerful and complete her battery in itself might be, its Services must in most cases be of limited avail so long as her machinery remained fatally exposed. It was therefore determined to complete the many advantages already obtained, and to provide for the Screw-ship a plan of engine which should be protected from injury by shot with the same security as that enjoyed by the Screw itself; and it was this determination which was foreseen to involve a contest with difficulties, second only in importance to the attainment of the object itself for the sake of which they were to be encountered.

That which is technically termed a 'Screw-engine,' that is, an engine, all the parts of which are protected from shot by a low position beneath the water-line, such as in various forms it has now been produced for the Screw-ships of the Navy, owes its origin to the determination to effect this great Object of Security; and that not the less so, because it was seen that it would greatly assist the intended means for rendering economical the General services of the Screw-ship, by its tendency to increase her stability when under Full Sail-power, from the low position of its weight.

Great difficulties in producing the present Screw-engine.

In producing this 'Screw-engine' for the sole purpose therefore of effecting a most important Naval object, it has been found requisite relatively to re-arrange even the elements of which the mechanical power of the Steam-engine itself is composed.—As a Marine Engine, it has been found necessary to re-model, and re-learn, the very alphabet of the well-known proportions and details of all which preceded it.—It has caused to be set aside and replaced, plans, patterns, and patents alike.—It has put masters and men to work again upon initiatory

labours mental and physical, with past principles, more than past practice for their guide.—And it has consigned to the risks of a fresh struggle upon a new field, the maintenance of hard-earned and long-established reputations.

As in England alone could a revolution of this nature have been expected to issue in a successful and speedy result, so was it seen that even in England this result could be expected to issue under the operation of but one plan of proceeding alone. And our undoubted possession at this moment of even a choice of engines by which the important object of Security is fully obtained, has been brought about,—not,—by committing the success of a great principle to the risks of an isolated experiment, or to the chance imperfection of some novel detail; but by employing the only reasonable and adequate means by which the attainment of an object of such difficulty could be hoped for, namely, by enlisting the energy and talent of the country in furtherance of the attempt. This could only be effected by issuing Contracts which should fairly remunerate for the anxieties, difficulties, and expenses, inevitably to be incurred, and by issuing these contracts to ALL;—under feelings of confidence which have not been misplaced, that the success of so large a stride in advance could yet with safety be relied on, when thus appealing both to the public and the professional spirit of the chief Engineering Firms of the kingdom for a general and emulative effort from each. And if the wisdom and soundness of the course thus pursued could be supposed to need any support beyond that of its actual success; that support would be seen in the fact, that each of the nine chief Firms by whom these contracts were accepted has entertained a separate view of the best mode of fulfilling the conditions required in them, and has illustrated that view by supplying us with a plan of engine distinctively its own.*

The means adopted for meeting those difficulties.

The success of those means.

* The parties by whom these contracts were taken are, Messrs. Bolton and Watt, Maudslay and Field, Robert Napier, Seaward, Miller, Penn, Fairbairn,

It was not, then, for the purpose of providing protection to the machinery of a ship equipped with no more than the incomplete armament of the Paddle-steamer, that difficulties and labours such as have here been pointed to were encountered and overcome. But the only, yet amply sufficient object ever contemplated, was 'to render effective for every exigency of warfare' that complete and essentially broadside battery, which by a simple act of adoption we now at once were able to re-establish upon the disencumbered deck of the Screw-ship; and which with ceaseless but fruitless toil, we had for years been labouring to plant upon the main and upper decks of the Paddle-steamer also.

Full Sail-
powers the
chief object
as regards
increased
Economy.

Again,—As COMPLETE Efficiency in every point connected with the armament was thus to be obtained only at commensurate expense; so with equal willingness was an actual price to be paid down, as the condition of perfecting the means of working the Screw-ship with COMPLETE Economy.

We have seen that the mere change of Instrument at once relieved the ship of the incumbrance of great top hamper, while the 'Screw-engine' removed the weights of machinery and propeller to the most favourable position for Stability below. The extent of the impeding surface when sailing, was also so much less in the new than in the old Instrument of propulsion, that without material difficulty or expense the Screw-ship could obviously claim superiority in Sailing-speed over the Paddle-steamer under equal powers of canvass, and even when equipped only upon this incomplete standard, she might pretend in some instances to take that modest position among

Scott, and Sir John Rennie; and that the term 'revolution' may not seem to have been unadvisedly used, each and all of the eminent engineers now named can testify that, whether as regards the selection by them respectively, of the principle of driving by 'gearing,' or the principle of driving 'direct;'—whether as regards the engines, or the boilers;—whether as regards themselves, their foremen, their workmen, or their tools;—General Principles alone guided the construction of the various plans of Engine supplied by them; and in every case General Principles themselves required to be modified and re-arranged.

the slower classes of the Navy as an effective Sailing-ship, from which her predecessor had with great loss to her general efficiency been necessarily excluded, and which she had been so long struggling against the disabling effects of her heavy incumbrances to attain.

Though great advantages in respect to the Economy of the Screw-ship were thus to be derived from the mere adoption of the change of Instrument, yet in this particular that change was also proposed and accepted with the intention that it should secure that full measure of the General and Economical employment of Steam, which could alone be derived from 'equipping and working the Full-powered Screw-ship as a Perfect Sailing-ship also.' And to effect this primary object completely, would evidently require the removal of the amount of impediment to speed which the surface of the Screw still continued to present when under sail alone.

The necessity for removing the Screw, in order to render full Sail-powers completely effective.

This removal therefore it was determined to effect, and to the determination thus to prepare for realizing the complete Economy of the Screw-ship is to be assigned the origin of the present 'Trunk and Lifting-gear;' by means of which the Screw can at any time be raised entirely out of the water, and which also supplies the collateral advantage of enabling the Screw to be examined whenever it may be necessary to do so.

In the various forms of completion in which this 'Trunk and Lifting-gear' are now presented in our several Screw-ships, a further task of no mean difficulty and anxiety has been imposed upon Constructor and Engineer alike. The accounts of both will testify that no mean expense has here also been incurred; and it is my desire to lay stress on this expenditure of money,—and anxiety,—and talent,—and labour,—and difficulty,—because together they constitute the price which has been paid,—not,—for that mere modified improvement in Sailing-speed which limits its success to the establishment of bare superiority over manifest incapacity. But it has been

Difficulties in providing for this removal.

paid for the sole purpose of eliciting that positively high Sail-speed which the fine and unencumbered Forms of these Screw-ships have ever shown that they possess;—the Economy arising from the almost constant employment of which Sail-speed being alone relied on to justify the heavy expenses incurred expressly to obtain it; because from that Economy alone was it expected that those expenses could ever be repaid.

Great expenses
of thus pre-
paring for
increased
Efficiency and
Economy.

Thus have been identified those CHIEF OBJECTS, upon its evident powers to secure which, both the original proposers and original acceptors of the Screw were content to base the propriety and the defence of its adoption. In thus glancing at the difficulties which that adoption was seen to involve, and at the means which alone could be depended upon in order to remove them, it has been my intention to show, First,—that improvements in every respect coextensive with such exertions of talent and expenditure were always looked to both to justify and reward them. And next,—that in every item of that expenditure and those exertions may be clearly traced the determination to realize the COMPLETE possession of all those ‘extensive advantages offered by the Screw under the two important ‘Heads of EFFICIENCY and ECONOMY.’

PART II.

THE AMOUNT OF PROVISION MADE IN THE SCREW-FLEET FOR
FULL-ARMED BROADSIDES.

HAVING thus pointed to the motives, intentions, and labours, concerned in the original adoption of that great change under review, I next proceed to notice the steps in course of progress for the further completion of the Screw-ship; and it is my wish to do so in a manner consistent with due respect for the Authority entrusted with the success of a System, designed to effect so total an alteration and improvement in the Powers, Practice, Principles, and Services of our Steam-fleet. Both in what has been already stated, as in what I now propose to add, a sense of the consideration to which so great a responsibility is justly entitled, has dictated a desire to remove,—and not to aggravate,—any embarrassments which a subject so extensive, so new, and so untried, may naturally be supposed to give rise to; and this desire I have thought would best be accomplished, by respectfully indicating that course of procedure which seems alone capable of consistently connecting the past with the present and the future, and thus leading to an early and satisfactory result.

It is henceforth assumed therefore, that the Objects now shown to have been originally contemplated, will continue still to stimulate our advance; and this assumed intention I have adopted with the greater confidence, because it would be difficult to replace these objects with others of equal National advantage, or more in accordance with feelings of Professional improvement. The further means of realizing them, however, should be reflected on with all that caution and prudence which is evidently demanded, while yet there continue to exist great difficulties in the way of their attainment, which must

The completion
of original
objects
assumed to be
still intended.

be met, and may be aggravated; and while yet there is ample room, notwithstanding all that has been done, if not for actual failure, at least for present disappointment, and delayed success.

The special advantages offered by the Screw-frigate for a powerful upper-deck battery.

Beginning then with the paramount Object of superior Efficiency as involved in the complete arming of the Screw-ship, it is satisfactory to recognise that valuable fruit has nevertheless been gathered from our past, although unsuccessful efforts, to equip effectively in this particular the Paddle-steamer; and that on the clear and uninterrupted deck of the Screw-frigate has been found perhaps the most powerful position afloat for the use of the Shell-gun, with its improved precision, lightness, and admirable mounting. The 'extreme training,' which when effectively provided for may here be given to it, together with its clearance from all obstruction of the rigging, may enable it with small assistance from the helm to be made in the Screw-ship a perfect chase-gun, while still maintaining its position in the broadside; and the complete co-operation with the guns of the main deck up to the angle of their 'extreme training' which may thus be secured for the entire upper-deck battery, is an advantage enjoyed by few, if any ships at present in the Navy, and must be found specially valuable in the well-appointed Screw-frigate when contending with Sailing-ships only, and realizing all the advantages of her Steam-power for the purpose of taking and maintaining a favourable position in action.

Both Screw-frigates capable of receiving a full broadside of guns.

Both on the main and upper decks of the two Screw-frigates, the preparation for the armament itself; its freedom from all obstruction of machinery; together with full security to every part of the engine below,—is capable of being complete.

The want of providing for a full store of coals in both the "Termagant" and "Dauntless."

But though our two Screw-frigates thus enable us to attain the great objects originally sought for and comprised under the head of Efficiency, yet it cannot be allowed to escape observation, with the view to future improvement, that in

connexion with this very success is to be seen what must be considered as an oversight in both their original designs. A complete battery has of course demanded a corresponding hold-space for provisions for the competent crew to work it. Complete protection to the machinery has at the same time demanded unusual room to be surrendered for the boilers below, in order that they may compensate in length, for their want of water-capacity in height, and compliance with these demands has pre-occupied a large portion of the space intended for fuel. It may be fair subject of regret that the "Termagant" and "Dauntless" are thus left with room for only 350, out of the 500 tons of fuel they were originally intended to carry, and our Constructors in their next designs for frigates of this description may well be warned by the deficiency in these; but even in respect to this deficiency regret need be by no means unmingled. The amount of Displacement to be disposed of in consequence of a smaller stowage of fuel than was contemplated, may be made to increase the power and extent of their armaments. And when provided with their intended Full Sail-powers, and realizing all the economy of fuel to be derived from the almost constant use of canvass, whatever "Steamers" of a fleet might on demand be found short of fuel, neither of the two Screw-frigates ought to be found in that position.*

Constitutes an oversight to be remedied in future constructions.

In these two ships there may certainly be seen a more uninterrupted plan of deck in the one case than in the other; and a further difference of two feet in the vertical height of the respective centres of machinery, seems to indicate that both protection to the engines, and stability to the ship, have been more carefully provided for in the "Dauntless" than in the

But both Screw-frigates in their respective degrees able to fulfil the objects of increased Efficiency.

* As it would appear to have been decided that ships of iron are unsuitable for the purposes of war, I have been unable to include in these remarks the four large Screw-frigates constructed of that material, and which it is understood are to be employed as Troop-ships only.

“Termagant.” In both of them, however, the original Objects comprehending superior Efficiency are capable of being absolutely obtained, and their respective Forms and their respective Engines, whenever tested, can alone decide the palm of merit between them.

The Screw-corvettes not prepared for a full broadside of guns.

It would be well if equal satisfaction could with equal honesty be expressed of the Screw-corvettes. But both Constructor and Engineer in the case of these vessels would seem to have been led away into a rivalry for superior speed at any sacrifice, rather than to have had regard to the higher object of an improvement in the essential powers of a ship of war; and we look in vain for the well-arranged and powerful broadside of the First-class Sailing-Corvette, supported perhaps by the Shell-gun ‘before all,’ such as these large ships might well have been expected to present. The embarrassments of unnecessarily-sized hatchways are here seen to inflict evils almost as extensive as the encumbrance of the Paddles themselves. They seem in some instances as if intended to perpetuate on the deck, the obstructions which had been removed from the side; and they have imposed in almost every Screw-corvette, an armament scarcely more complete whether in power or position than that of the Paddle-steamer of equal size.

But their engines fulfil the object of being in security below.

The various plans of engines in these Ships do all indeed fulfil more or less perfectly the condition of protection from shot; but it is to be feared that expensive re-arrangement of their decks may yet be necessary, ere the batteries themselves which the engines carry into action can be made worthy of the labour and talent which have been bestowed in order to render their services available in all circumstances of warfare. And we may yet be compelled to look to future ships of this class wherein to realise with completeness the advantages which the Screw was expressly intended to secure for them;—the chief objects and designs of which would seem from the very commencement of the present Screw-corvettes to have been over-

looked and violated, and to circumstances in direct connexion with which violation may be traced the disappointment they have already occasioned, and the increased expenditure which they yet may require.

In making these remarks, it is my wish to state only that which observation and reflection have led me to believe correct. I do so under feelings of regret, but by no means with the assumption to impute blame. It is neither my purpose nor my province to censure, and were it either, it would be difficult not to see that there are considerations quite numerous and weighty enough to prohibit it.

It will be at once seen that the distinct character of the two classes of ships would of itself keep the intention of a complete battery more constantly in view in the Frigate, than in the Corvette. And it is well known that the lengthened period which has been required to advance these ships even to their present stage of completion, has been characterized throughout by little short of a mania for increased speed in all things, and almost above all things, and Steamers of every sort have been by no means exempt from the infection. Large and expensive, although necessary alterations have also been made in all the Screw-ships during the period of their construction, having this end alone in view. And a further though unintentional support to this general bias may yet have been given, by actually pitting the two principles of the Screw and the Paddle—illustrated respectively by the “Niger” and “Basilisk,”—to contend for superiority in this very quality of Speed, under provisions made expressly for the contest; of the same Constructor, the same powers, and the same forms, on both sides. Thus has a combination of influences tended to mislead the mind into an erroneous, but still into a consistent belief, that the attainment of this predominant desire of the day must necessarily have been the great object intended by this new mode of Propulsion also, to the exclusion of the less prominent

The objects
of increased
Efficiency
overlooked in
the desire for
increased
Speed.

though infinitely higher intention of constituting the future Screw-ship a full armed, and fully equipped Sailing-ship also.

The assumed
causes of this
oversight.

Nor is this all which may be seen of combined influences, circumstances, and times, all tending to divert the mind from a clear view of the original and real intentions contemplated by the extensive change which was being introduced. For it did chance that the period of the full adoption of the Screw fell in, as if on purpose to illustrate that peculiarity in the Constitution itself of the government of the Navy, under the operation of which, all the difficulties and responsibilities of successfully bringing to issue a very extensive and important project, comprehending the application of untried Powers, Principles, and Practice, were to be fixed upon parties who had nothing to do with introducing it; nay, who might entertain very grave and substantial doubts as to the wisdom and propriety of its ever having been introduced at all. And to minds suddenly subjected to all the natural anxieties arising from a situation of such responsibility;—which could previously have possessed no special means of knowledge on the subject of the Screw;—which could be expected to have devoted to it no exclusive time or attention;—and the current duties of whose new positions demanded the full occupation of every moment, for labours requiring more of decision, than of lengthened study and reflection;—to minds thus circumstanced there were not wanting at the time in question sound reasons why such doubts should reasonably find admittance. Great misapprehensions as well as misrepresentations were then in many quarters, and for many reasons, very rife about the Screw. Its advocates were few and powerless, its opponents were many and influential; with all the *prestige* on their side of past Steam-experience and success. Its powers, principles, and pretensions, were therefore in course of being both extensively and boldly challenged; and precisely at the advent to power of the Board of Admiralty who were to inherit

the responsibility of its future success, its patrons on the one side, and its opponents on the other, were found engaged in earnest controversy on its merits and performances. That the arguments of the opponents were not without their share of influence may reasonably be inferred from the issue of a Circular proposing to the various Engineers concerned, a suspension of all contracts then under completion for the Screw. And thus may be seen a chain of influences and incidents quite sufficient to account most naturally for original Objects being overlooked, while it forbids the imputation of blame to any, although the inevitable oversight arising from such circumstances may as naturally give rise to feelings of regret. Indeed, instead of any such imputation being chargeable anywhere for any such result, may it not rather be a subject of general congratulation to all concerned in carrying out an undertaking requiring so much of mature reflection; commenced and prosecuted as it has been under auspices so untoward; that a greater departure from First Principles has not rendered our return to them still more difficult and expensive? *

* Since the foregoing pages were penned considerable advance has been made towards completing the broadside force of *some* of the Screw-corvettes, but as yet none of them present a battery at all proportionate to either their great size or great cost. It would seem, on the other hand, that the "Termagant" is not capable of receiving her armament as a frigate of 28 guns, while the "Dauntless" is capable of having hers materially increased.

PART III.

THE PRINCIPLES OF PROVIDING THE SCREW-FLEET WITH
FULL SAIL-POWER.

I NOW close the review of the present equipment of our Screw Fleet, under that division of the subject in which I have treated of its progress towards attaining the two great Objects originally comprised under the head of EFFICIENCY. As regards the one of these objects, that of a complete broadside armament, I have shown the preparation for its complete attainment in the Screw-frigate, and I have pointed to the presumed causes of the want of preparation for its attainment in the Screw-corvette; as regards the other of these objects, that of full security to the Machinery in time of action, I have shown its complete attainment in both Frigate and Corvette alike.

The success of
the Screw-ship
dependent on
her Economy;
and her Eco-
nomy depen-
dent on her
equipment
with Full
Sail-powers.

I now proceed to consider the circumstances of our Screw Fleet, as regards its future progress to success, and under this division of the subject I must treat of the yet unattempted completion of the Objects originally comprised under the head of ECONOMY. I am aware that future success must decide upon the substantial value of the very Principle itself of the Screw; I am aware that on proof or failure of its practical economy its success must be judged to stand or to fall; and I am equally aware that effectively to apply the only means by which this proof of its 'practical economy' can be given, will involve a contest with difficulties, moral and physical, ranking second to none which have yet been met and overcome. I therefore enter upon this portion of the subject with diffidence and caution, but neither with doubt nor fear, and still closely adhering to original objects in all their integrity. In defining those 'original objects' it was stated that the means to be

employed for realizing Economy in all the Services of the Screw-Fleet was to equip and to work the Full Powered Screw-ship, as a Perfect Sailing-ship also; and since every portion of success in an undertaking upon which so much depends has yet to be reaped, the following examination of the principles of applying Full Sail-power to the Screw-ship is chiefly directed:—First,—to define the extent to which any past Sailing-experience can or cannot be safely trusted to, to guide us to our end:—And next,—to fix attention to those ‘special causes’ which so strongly enforce the necessity, that the Full Sail-power to be supplied to the Screw-ship should be suitable—as well as sufficient.

Any examination for such purposes, to be useful must be complete, and must include all known or discoverable difficulties. And difficulties there will be seen to be, which are not slight, and which cannot be evaded. They present perplexities in Form;—anomalies in Dimension;—peculiarities of Service,—such as are to be neither seen in, nor expected from any other Class of vessels ever yet proposed for ‘perfect’ Sailing-ships. They bar all avenue to any hope of carrying Success by storm, and promise to yield it only to the slower but surer process of a close and patient investigation into the Principles of applying Sail-power in our best known and most successful cases, in order that we may so mould those principles, that with reason and confidence they may be expected to yield a similar result, from a similar application of them to the peculiar case of the Screw-ship also.

An examination into the difficulties of making the Screw-ship a Perfect Sailing-ship requisite.

That there may be no mistake then as to what is here intended by a PERFECT SAILING-SHIP, I now define the term as here applied, practically to mean this;—‘That for the ‘execution of any Service demanding no more than the speed ‘of the best Classes of our Sailing-ships; an Admiral, with ‘both a Frigate and a Screw-frigate alike at his disposal, ‘should be able indifferently to select whichever it might be

A definition of the term “Perfect Sailing-ship,” as applied to the Screw-ship.

‘desirable to employ, with assurance that, as far as regards speed under sail alone, such Service would be performed with equal effect and celerity by either.’

And further;—‘That as regards Services involving her double capacity, the Screw-frigate should be in every respect eligible for selection to accompany under sail only an expedition of the fastest Sailing-ships to a destination however distant, with assurance of her arriving in company on the scene of action bringing to the aid of her Consorts her unimpaired powers as a Steamer.’

No standard of requirements short of these could vindicate its claim to the title of—perfect. No lower standard could justify the talent, money, and labour which we have expressly expended in order to attain to this one alone; because none lower could be expected to offer either return or reward commensurate with such expenditure. And although perhaps in terms so specific it may not originally have been found necessary to define it, yet even the Paddle, could it have caught a glimpse of success, must have stayed its efforts at the attainment of no standard short of this; while as regards the Screw, ever since the day of building the “Archimedes” it was always proposed and intended that whatever speed under canvass had as yet been accomplished by the Sailing-ship, should be required,—because evidently to be expected,—from the fine form and sailing proportions of the Screw-ship also when equipped with equal Sail-powers.

The sailing experience of the Paddle-steamer inapplicable to the case of the Screw-ship.

Having thus fixed the intended standard of sailing-merit for the Screw-ship, we will at once examine what assistance in attaining to it we may expect from the past years of sailing experience afforded by her sister of the Paddle. And for this purpose it is important to observe, that from the days of the “Medea” down to those of the “Terrible,” there has been one long continuous struggle;—one constant exertion of every effort which practical talent and professional experience could

command, in order to render 'perfect' the sailing of the Paddle-steamer, with the very same object of rendering perfect her economy also. Nor has she at any time been stinted in her supplies of materials and means. They have been throughout most liberal, if not lavish. In most cases every new commission has been commenced by fresh efforts—carried out with improved means,—increased hope,—renewed energy. And early disappointment, in not a few instances, has only given occasion to repeat the attempt within the period of the same command; in testimony alike to the value of success so justly entertained by Authorities ashore, and to the zealous co-operation with which they have been supported by Officers afloat.

And all this with what result?

Relatively, no doubt, with great improvement to individual vessels among these Steamers as a class; yet even this improvement is unattended to this day by the establishment of any fixed and well-defined System of Sail-power appropriate for them generally; in the amount of which can be seen satisfactory promise of speed; or in the mode of which can be traced the principles of permanence. But as regards the attainment to any standard of positive sailing-merit however moderate as ships of war, the extent of the failure in the Paddle-steamer is only more clearly illustrated by the extent of the means which have been employed for her success.

Inability to
render the
Paddle-steamer
a Sailing-ship.

Should the fastest of them be now selected to start on equal terms, in variable weather, and under canvass alone, in company with a good sailer from any class of ship in the Navy, it is not too much to say that in a voyage made under such conditions from Falmouth to Gibraltar, the Paddle-steamer would justly deem her work not ill performed by finding herself preceded at the 'Rock' by 48 hours only.

Cause then her side like that of the Screw-ship to be relieved from every obstruction whatever connected with her Steam propulsion.—

Causes of that
inability.

It matters not; for there remain in full operation all the causes of her instability still; totally debarring her from the employment of that amount of Sail-power which is requisite in order to drive her bulk and its resistances with speed.

Remove then her top-weights of hull and machinery and give to them the same favourable position for affording stability when under a Full Spread of canvass which they occupy in the Screw-ship.

It matters not still; for were it practicable to do so, it could serve only to improve her average speed, by improving one of its—separate,—not combined sources, and so long as the Paddle-wheel continues to be the instrument of her Steam propulsion, so long must she be incapable of employing Sail-power effectively and constantly for every general use. For such removal and such improved stability, were they possible, and were they accompanied with an equipment with full Sail-power, could only still serve to expose that essential distinction between the Paddle-steamer and the Screw-ship which for all general circumstances admits of this definition;—

Conditions of
the Screw-ship
and Paddle-
steamer under
canvass essen-
tially distinct.

‘That whereas the one will sail best without her Paddles, and paddle best without her Sails;—the other will screw the fastest with her Sails, and sail the fastest with her Screw.’

The distinction in short, which must ever continue to exist between two recipients of like powers; which powers in the one case are capable of complete co-operation at all times for the duty to be required, while in the other they are with slight exception antagonistic alone.

The sailing
experience of
the Paddle-
steamer only
mischievous as
applied to the
Screw-ship.

These things are not advanced with the intention either unjustly to depreciate the one, or unduly to exalt the other. But if they be substantially true, and if they go to prove by the evidence alike of sound principle and long practice, that the Paddle-steamer cannot lay claim to a standard of any positive sailing-merit whatever; then that proof may fairly be advanced as sufficient cause for declining her assistance as in any degree

serviceable for the Screw-ship, which can lay claim to take a very high one. That proof may fairly be advanced when it is intended to show that the Paddle-steamer must be regarded in 'positive sailing matters' as of not the least authority; and when it is intended to warn that her influence in such counsels must therefore embarrass, but can never be expected to aid them. Her experience might be useful for reducing a higher standard to approach her own; but it should never be appealed to for establishing one so much above her powers. The reverse of such proceeding would be by far the sounder course in the present instance to pursue. It seems reasonable to conceive that in striving to perfect an appropriate System for the Screw-ship, it may be found that we are establishing one of modified benefit for the Paddle-steamer also; but I have felt it very important to show, that in having recourse to the imperfect equipments and experience of our Paddle-steamers in order to frame from them an effective Sail establishment for our Screw-Fleet, we are at once betraying the weakness of the one, and very injuriously underrating the powers of the other.

Reason and necessity then combine to bid us look for our model to the already perfected Sailing-ship; presenting as she does the standard we desire to reach; and showing as she does the same disencumbered side and full spread of canvass, for an equally effective use of which the Screw-ship has been so expensively prepared. And though there may be some misgiving at the difference in Stability of Form which is apparent in the two descriptions of vessels; yet there are advantages to be seen upon the side of the Screw-ship,—in length,—in disposition of weights,—in draft of water,—all tending to compensate the comparative deficiency in the stability of her proportions, and which advantages, when added to the possession of finer lines and greater delicacy of form, afford ample encouragement to hope that the Screw-ship, when supplied with equal proportions of Sail-power, will be found a

The sailing experience of the Sailing-ship the natural standard of reference for the Screw-ship.

successful competitor for equal speed with the fastest of our Sailing-ships.

But the difference in dimensions of the Sailing-ship and Screw-ship must require a difference in the mode of applying their Sail-power.

With our course thus taken then, the next step may be to select that Class of our fast Sailing-ships which seems to present the greatest similarity in general features, and may therefore be expected to supply the Screw-ship in her Sail-equipment with the most appropriate aid for the details of a Rigging Establishment. And at this preliminary and very obvious stage in our progress, the dimensions which have been necessarily imposed upon the Screw-ship in her capacity as a Steamer, force themselves so prominently into notice that a comparative examination of them is evidently the very first proceeding to be adopted before any further advance towards our object can be made.

This difference of dimensions illustrated by the case of the "Dauntless."

In conducting such a comparison, I shall select with the view to its clearer illustration, a particular case;—a case to which this comparative examination has actually been applied; and which, as being that of our completest Screw-frigate, is one also which will best afford data for other classes of the same description. The "Dauntless" then may be seen to possess a length between the perpendiculars of 210 feet, or rather more than that of the larger Three-decker. A load displacement of 2,432 tons, or equal to that of the present largest class Fifty-gun frigate. An extreme breadth of 39 feet 8 inches, or similar to that of our new class Twenty-sixes. And an area of immersed midship section amounting to 542 feet, or identical nearly with that of the frigate of Thirty-six-guns. Results it will at once be allowed of such a nature as to render hopeless the expectation that the Rigging Establishments of any one of these classes of ships, or even of all of them put together, could be made to furnish appropriate details of Sail-equipment for dimensions so anomalous.

An examination into the

Here then is the first barrier, and it may require some consideration to overcome it. It enforces first and inevitably,

that the Screw-ship in her Sail-equipment must be dealt with on her own Merits alone. And next it points to a patient research into the past principles of applying Sail-power instead of an unsound and hasty resort to any of the defined forms in which hitherto we have applied it, as the only safe mode of grappling with dimensions so dissimilar from any which have ever yet been included in our Sailing-fleets.

Principles of applying Sail-power in the several classes of our Sailing-fleet thus becomes requisite.

In prosecuting such a research, therefore, we will proceed to examine as the first witnesses these very ships themselves; that is, the Three-deckers,—the Fifty,—the Thirty-six,—the Twenty-six-gun frigates,—and all other classes and descriptions of our Sailing-fleet,—with all their various dimensions;—at all their various demands;—for all their various services, circumstances, and situations.—We will inquire of all these how **THEY** have found that the principles of Sail-power could with such perfect effect be made applicable to each of them? And if we can succeed in finding a general basis upon which these principles have hitherto been so variously yet effectively applied; then we need not be discouraged by the difficulties of the present case, but, on the contrary, the same basis will evidently afford the safest guidance for so applying them, that with the same perfect effect they may be made to suit the circumstances of the Screw-ship also, however anomalous and peculiar in her dimensions, duties, and forms.

This examination made.

It will be necessary that the points involved in an inquiry of this nature should be considered a little in full.

From the Three-decker then, to the jolly-boat inclusive, we are presented with all the well-known varieties of Sailing Form ranged in those distinct and long established Classes, with which we are all familiar. And whence, we will ask, has arisen the necessity for all this variety and modification of Form, instead of adopting the obviously simpler system of perfecting one common type for all? Solely,—because in framing the equipments of each new description of ship as the necessities of various times

have called them forth; the characters assigned to, and the duties required from them, have demanded and have received their due share of consideration by fixing the mode and the extent of their Sail-power, *in proportion to their several resistances and stability*. Solely—because of the obvious necessity of thus supplying effectively, in order to work successfully, each different description of ship within the sphere of its own character and duties upon its own Merits alone. And therefore under the conditions of this necessity no common type could be found, nor could be expected to be *made*,—appropriate,—for all Classes and Services alike.

Sufficiency with respect to "Resistance," and Appropriateness with respect to "Stability," are the basis of all effective application of Sail-power.

In the fixed and definite Sailing Forms therefore which we daily see around us and to which we are so well accustomed, we also see universal witness borne to a fundamental Principle in the application of Sail-power, which has ever ruled in our Navy; which has stamped with its mark all that we recognise as stable and permanent in it; and which has ever been that, 'of appointing to each description of Ship in reference 'to the merits of her peculiar character and intended Service, 'a sufficient and appropriate equipment.' And all these various Sailing Forms are fixed,—are definite,—are stable,—and we recognise and quote them as such, only so far as in accordance with the conditions of this Principle, time and trial have proved them to be sufficient and appropriate.

And negative proof of the binding necessity of these conditions is as clearly to be drawn from the present day; as positive proof from the past. For in the constant changes of plan, arrangement, and extent of Sail-power, before remarked on, as those to which the Paddle-steamer is yet subject, there is the clearest evidence that men's minds will not allow that any Sail-system which has been as yet applied to her, is entitled by the warrant of extended experience to the permanent indorsement of 'Sufficient and Appropriate.' And therefore while changes and alterations are yet in progress we are clearly required to believe

that they can only originate from the as yet unfulfilled necessities of the Principle pointed out.

Having thus ascertained this general basis of application, we may now proceed to inquire—But how reconcile this necessity for constantly varying Forms, according to constantly varying demands, with the fixed and acknowledged advantages of classification? Simply, and easily; and precisely so because classification itself is but a higher operation of the very same Principle. The division of various Classes into their well-known features of—Square-rigged, and—Fore-and-Aft-rigged; the modifications of either Form—and the combinations of both;—these all constitute and continue integral members of their respective groups, and they there realize all the advantages of Simplicity, Economy, and Order, solely in virtue of that final stage in the completion of the very Principle above stated called Classification. For ‘Classification,’ wherever sound and permanent and producing its legitimate fruits, has been based, and only can have been based, on the prior state and condition of—APPROPRIATENESS.

No Sail-equipments can become permanent until found to be “sufficient” and “appropriate.”

First must be fixed the distinctive characters and duties to be assigned to each description of ship in fulfilment of the demands which have called her forth.—Her Merits must be defined. Next must come the appointment of sufficient and appropriate Powers for the development of those Merits. Then, and not till then, may the operation of Classifying those Powers commence; because then,—and not till then,—can such Powers, in whatever form or extent they may have been demanded, assume a fixed and definite character. Classification presupposes the assortment together of things similar, not dissimilar. She must reject that which is subjected even to dissimilarity because the integrity of her operations must be disturbed by it. And there can be no guarantee for the essential condition of similarity; but there is every guarantee for the opposite condition of dissimilarity, while that which is ‘Appropriate’ is as

No Sail-equipments can be classified until thus proved to be permanent.

yet only in process of being sought for; while as yet it is undiscovered,—unproved,—and undefined, and therefore while as yet a state of things exists in which changes and alterations are inevitable. While yet this incomplete stage of organization is in progress, to attempt to impose Classification upon it is to violate the very order and harmony of things. It is to deceive ourselves; and to injure that which it is desired to benefit. It is to increase disappointment; and in reality to postpone the completion of that to which it affixes the immature stamp of a specious but spurious finish. Classification to be useful, sound, and permanent, can only be based on that which itself is also permanent; and that only can be permanent which is also appropriate; and that only be appropriate which has strict regard to the Merits of the special case of its application,—to the character and services it is intended to develop. And to expect that the legitimate results of Classification can arise from its forced application ere these its natural foundations have been securely laid, is not simply to commit the error of misplacing the consequent and antecedent; but it is to commit an error which in its effects can only produce Confusion and Waste, out of what has been provided for Economy and Order. For it is to expect that the advantages and stability of a sound System of organization can arise, where the Capital of the structure has been mistaken and substituted for the Base.

The necessity
of adopting
these Prin-
ciples in
appointing the
Sail-equipment
of our Screw-
ships.

In these days then, when in the progress and advance of the times there has been called forth a totally new description of Ship, uniting to the increased Efficiency of modern powers, all the Economy to be derived from retaining the use of the old—What is it proposed that we should do, more than ever has been done in such cases, when we enforce the necessity of inquiring into the character, forms, proportions, and services assigned to such Ships, for the purpose of framing their Sail-equipment with reference alone to these their Merits? And if on this inquiry it be seen that in all these respects, as

well as in their combined powers, these Screw-ships exhibit peculiarities exclusively their own, will it therefore be unusual, or if unusual, improper or unwise to examine the more closely into the Principles of applying Sail-power in the instances in which they are most successfully and completely applied, and where they offer the most important features of resemblance, in order that with equal success, these Principles may be made to suit the case of this new description of Ship also? It is evident that all past custom, all sound experience, and it might be added sound sense, require of us to follow in no other course. And as I think it quite possible that we have deviated from this established mode of procedure—that we have attempted to force plans upon the Paddle-steamer, which have not had this strict regard to her Merits;—the principles of which have not been sufficiently studied;—and have not been appropriately applied:—and that to deviations of this nature may be traced much of the failure as yet attending the endeavour to provide her with a fixed and definite Sail-system. So, with this warning and this encouragement from the past, and with renewed confidence in the soundness of acting in the present instance on the Principle traced out, I now proceed with the further stages of that examination from which I have thus been led to digress.

Looking then in furtherance of our purpose to the Six-and-twenty-gun ship and the Three-decker, it will at once be seen that while neither of them as a class supplies the highest standard of sailing-merit, the dimensions of the one are as much too large for useful analogy, as those of the other are too small. A similarity of Displacement offers again the only point in common with the Fifty-gun frigate. But in the case of the Thirty-six-gun frigate we not only have the very standard of sailing-merit it is desired to attain, but in addition to an approximate armament, and an approximate crew, we have also a close identity in the Area of immersed midship Section; the very measure of Direct Resistance, and therefore the most

The "sufficiency" of Sail-power with respect to Resistance ascertained in the case of the "Dauntless."

important element for consideration in all cases of comparative speed.

Accepting then the assistance here offered we find that experience has taught, that the requisite proportion of Sail-power for the production of the high speed of this class of ship is 37 square feet of canvass to every surface-foot of this 'immersed midship Section;' and adopting the same rule therefore for the Area of the section of the "Dauntless," we at once get the definite spread of 20,054 feet of Sail as that which will be requisite in order to place her on an equality in this regard with the Sailing Frigate.

The disparity in Displacement, or Measure of Mass in the two cases, will next present its share of difficulty; forcing consideration to the necessity that the Sail-power of the Screw-frigate must be subjected to the unequal burthen of setting in motion and preserving the speed of a Ship 538 tons larger than that which the Sail-power of the Frigate has to exert its effort upon. An addition of 1000 feet to the canvass of the Screw-frigate will perhaps enable her to meet the large disparity in this element of 'Displacement,' and it may then be assumed until disproven by actual trial, that the finer lines of the Screw-frigate, together with the ability from the distance between her masts frequently to apply the aid of her gaff-sails, will compensate for the superior proportions of Power to Mass which a comparison with the Frigate still shows her to possess.

The sufficient canvass for the "Dauntless" is thus seen to amount to not less than 21,054 feet.

The difficulty of applying the sufficient Sail-power appropriately, stated and met.

But it may be asked; admitting all this to be a correct process of practical and sound induction, how are we to expect that this 'sufficient' Sail-power is to be carried with due regard to the effective working of her guns, by a ship whose Stability of Form exhibits nearly 7 feet less beam than the class of Thirty-six Gun Frigates with which we are comparing her, and which carry 19,761 feet only?

The difficulty here presented is without doubt a most serious one, and involves the whole case of the success of the Screw, for the consequences of yielding to it are self-evident. In such case the intention, together with the advantages of constituting the Screw-ship a Perfect Sailing-ship also, must be abandoned; and all the past labour and past expense of preparing her for Perfect Sail-power must be sacrificed for the attainment of a mere improvement in Sailing-speed; and therefore a mere improvement in Economy; and therefore a mere improvement in the general use and employment of Steam through her means; and to another and a future generation we must be content to bequeath the task of perfecting that of which we laid the foundation only, but possessed not the ability or the perseverance to complete.

The discouragement of any such abandonment however need in no wise be contemplated; for the 'sufficient' Sail-power thus shown to be requisite for the "Dauntless" may yet be rigidly adhered to, and not one foot of its extent need be sacrificed, in solving upon a basis equally as sound and satisfactory as before the harder question perhaps, of applying it 'appropriately.'

It would not accord with the intentions of this paper to intrude into it the tedium and detail of calculations. Suffice it, that to arrive at such solution it was requisite to analyse the action of the Motive-power as well as the Stability in their elementary forms, such as they could be shown comparatively to exist in an actually known and proven case on the one hand, and a carefully and appropriately projected one on the other, and for such process no higher standard with which to compare the "Dauntless" could be hoped for, than that supplied by the "Thetis." The conclusions arrived at gave satisfactory conviction to all who kindly aided in making the comparison, that the proportions of our Screw-ships present the means of balancing the Inclination of their sails, against their Stability, upon principles which ensure their being able to carry with no

The "sufficient" Sail-power with respect to Resistance applied "appropriately" with respect to Stability in the two comparative cases of the "Dauntless" and "Thetis."

more than the Frigate's inclination, the same proportion of Sail-power to Resistances which produces the Frigate's speed ; and the principle deduced may be stated thus :—

A general definition of the mode of applying full Sail-power in both Screw-fleet and Sailing-fleet upon the same Principles.

“ THAT THE ‘ MOMENT OF INCLINATION ’ OF THE CANVASS
 “ DETERMINED AS SUFFICIENT, IN PROPORTION TO THE
 “ DIRECT RESISTANCE AND DISPLACEMENT ; IS CAPABLE OF
 “ BEING ADJUSTED IN THE SCREW-SHIP TO THE ‘ MEASURE
 “ OF STABILITY,’ CALCULATED FROM THE CUBES OF THE
 “ ORDINATES OF THE LOAD-WATER LINE ; SO THAT THEY
 “ SHALL BEAR TO EACH OTHER THE SAME PROPORTIONS, WHICH
 “ BY MEANS OF THE SAME PROCESS THESE ELEMENTS ARE
 “ SEEN TO BEAR RELATIVELY IN THE CASE OF THOSE SAIL-
 “ ING-SHIPS, WHOSE SERVICES IT MAY BE MOST DESIRABLE
 “ THAT THOSE OF THE SCREW-SHIP SHOULD RESEMBLE OR
 “ SUPERSEDE.”*

For the purpose of practically working out a defined System

* The following are the data of the actual comparison instituted between the “Thetis” and the “Dauntless,” and may serve to illustrate the definition I have here endeavoured to state :—

The plan of Sail-equipment for the Screw-ship was of course projected upon the principles above advanced, and in doing so, advantage was taken of her greater length, in order to reduce the ‘ Moment of Inclination ’ of her canvass until it approached to within one-fifth of the same proportion to her ‘ Measure of Stability ’ as these two were seen to bear to each other in the case of the “Thetis ;” and which practically would have amounted to this : that under such circumstances of wind and weather as would give to the “Thetis” an inclination of 5°, the “Dauntless” similarly circumstanced, would have had an inclination of 6°.

This approach of the two elements to the same relative proportions, was considered quite close enough in the case of this particular comparison, because this mode of examination has reference only to the ‘ Stability of Form ;’ and there are other elements of Stability besides this, which were seen to be very largely in favour of the Screw-frigate, and which therefore claimed consideration. Thus for instance,—

The disposition of the whole weights of the machinery amounting to above 400 tons, is such as to bring the centre of gravity of this mass very low down.

There is a difference of nearly two feet in favour of the Screw-ship in the disposition of the weights of the Main and Upper Decks, with all their armaments.

A difference of rather more than two feet also in her favour in the relative draughts of water.

And in addition to these, the plan of Sail-equipment was also projected upon principles

thus based upon known laws, and deduced from long experience, the Screw-ship offers every facility in her length; and to take

principles which would give a much lighter system of spars and rigging aloft to the Screw-ship than to the Frigate, in order to meet the necessary requirement imposed upon her of having often to strike them. So that there were ample means of compensation for the deficiency in the comparative proportions of the 'Inclination' and 'Stability,' and ample assurance that the amount of canvass determined as 'Sufficient' for the "Dauntless," would be carried as appropriately with respect to inclination in her case, as in that of the "Thetis."

The comparative 'Measures of Stability' are estimated for an indefinitely small angle of inclination, by using the cubes of the Ordinates of the Load-water lines and applying to them the Formula used in calculating the Areas of these curves, which is a method of approximation sufficiently close for every purpose of comparison. And the drawings used did not include the outer plankings in either case, but in both its thickness is the same.

| Comparative Data. | H.M.S. "Thetis." | H.M.S. "Dauntless." |
|--|-----------------------|------------------------|
| Length, extreme, upon the load-water line | Feet. 164.5 | Feet. 206.5 |
| Breadth, extreme | 45.2 | 38.4 |
| Area of load-water line | 6292.2 | 6717 |
| "Measure of Stability," estimated as above | 1390024.2 | 1062852.6 |
| Area of sails; including courses, topsails, top-gallant sails, jib, } fore-topmast stay sail, and spanker | Square Feet. 19761 | Square Feet. 21041 |
| "Moment of Inclination" of sails | 1398845.2 | 1976950.3 |
| "Centre of Effort" above load-water line | Feet. 70.78 | Feet. 60.68 |
| "Centre of Effort" before centre of load-water line | 7.36 | 8.56 |
| Immersed area of midship section, or "Measure of Direct Re- } sistance" | Square Feet. 533 | Square Feet. 540 |
| Immersed area of ship longitudinally, or "Measure of Lateral } Resistance" | 3207.75 | 3613.75 |
| Load Displacement, or "Measure of Mass" | Tons. 1894 | Tons. 2432 |
| Area of sail, per foot, of immersed section, or Proportion of } Power to Resistance | Square Feet. 37.07 | Square Feet. 38.98 |
| Area of sail per ton of Displacement, or Proportion of Power } to Mass | 10.43 | 8.65 |
| Height of midship Maindeck port-sill above water | Feet. In. 8 3 | Feet. In. 6 6 |
| Mean load draught of water | 19 6 | 17 4 |

The statement for the calculation, according to the terms of the definition, would therefore stand thus—

"Moment of Inclination" . The Measure of Sta- . . "Moment of Inclination" .
of Sails in "Thetis" . bility in "Thetis" . . of Sails in "Dauntless" .
x

the result going to show the difference of proportion in the elements in the two cases to be favourable or unfavourable, according as x is greater or less than the ascertained value of the "Dauntless's" 'Measure of Stability.'

advantage of this length, in order to give to her canvass a low, instead of a lofty "Centre of Effort," is a proposition which should rather meet with the approval of the seaman than otherwise ; although in carrying it into effect it may be necessary to adopt proportions and forms, which like those of the Ship herself, differ from anything to which his eye has been hitherto familiar.

The difference of dimensions in the Screw-ship and Sailing-ship thus admit of the application of full Sail-power upon the same Principles, modified to meet their respective cases.

Those shorter proportions of length to breadth, which obtain in the case of the more ordinary Sailing-ship, have compelled her for want of longitudinal room to carry the amount of sail required for her speed, not low, but loftily ; and the increased 'Moment of Inclination' thus produced is in her case counteracted by the increased 'Measure of Stability' derived from a proportional breadth of beam, supplied at and about the water-line for this very purpose, the 'Area of Direct Resistance' being kept at a low figure by the fineness of the underform. Now the Screw-ship in order to carry her machinery low, is necessarily constructed with a fulness, instead of a fineness, of underform ; but if we also compel her to carry her canvass loftily, we shall then require the increased beam also which is necessary to resist its inclining pressure, and in such case it is clear that we must enlarge the 'Area of Direct Resistance' to such an extent as to render the attainment of high speed in the Screw-ship hopeless. In her case however the conditions of such a necessity do not exist. The room which in the shorter Sailing-ship cannot be found, is presented to us in the greater proportionate length of the Screw-ship to enable her to carry her canvass,—not loftily,—but low ; and she thus possesses the ability to have the 'Moment of Inclination' of her sails reduced, until her reduced breadth of form is enabled to resist its inclining pressure with the same 'Stability' as that of the Sailing-ship.

Nothing new then, nothing but that which has the stamp of practice and experience is to be seen in the Principles of apply-

ing Sail-power appropriately and sufficiently, which have been here advanced as those which can alone guide our efforts to 'perfect' the sailing of the Screw-ship with safety, confidence, and success. They are the same which in all past times have in similar cases been acted on, and their modification, to suit the circumstances of the peculiar description of Ships now under consideration, should follow as a matter of course, with the demand of the times which has called them forth. It is equally within the sphere of the legitimate action of these principles that in the present times the *mode* of Sail should, in the Screw-ship, be made to meet the character of a full but narrow form of body which the engines have imposed on her; as, that in past times the Sailing-ship should have received a fine but wide form of body in order to resist the inclination imposed by the manner in which she must carry her *amount* of Sail. The two operations though different in mode are alike in principle. In both, the common object is to employ the 'Sufficient Sail-Power' which high speed demands, and in both there is the common necessity to limit the inconveniences of that 'Inclination' with which every application of Sail-power is necessarily attended.

We next proceed to another stage in illustrating the necessities imposed by the distinctive character of our Screw-ships; and turning from the further consideration of their peculiar Dimensions, I shall endeavour to show the necessity for an appropriate equipment, with respect to their peculiar Services also. Let us, then, suppose the "Dauntless" to be supplied with the same proportional spread of canvass as the "Thetis;" its Centre of Effort reduced with due regard to her narrower beam, but in other respects her Equipment exhibiting the features presented by all other square-rigged ships.

The question then arises: how far in such mode of Equipment is such a ship suitably provided for the efficient performance of the Services she pretends and is sent forth to execute?

An appropriate Sail equipment for the Screw-ship necessary with respect to her peculiar Services as well as her peculiar dimensions.

How far is she 'suitably' rigged for the rapid transition in foul weather as in fair, from Perfect Sailing-ship to Full-powered Screw-ship, and steam duties finished, back to Perfect Sailing-ship again? It is hoped that no lengthened reflection will here be required in order to stamp a still stronger impression, that consistently with a due regard to her double capacity, the Screw-ship cannot without violation of her intended design, without certain disappointment, and certain expense,—be forced into analogy of detail with either the Steamer or the Sailer which has preceded her, the Powers of both of which she is provided with, and the Services of both of which she is intended combinedly to fulfil:—an impression, in short, that she must be 'suitably' provided with reference to her own Merits alone as the only means to her being successfully worked. For one or other of these two conclusions must force itself on every practical mind, on seeing as above supposed, such a mode of ordinary preparation made for the execution of Services so unusual. Namely, that when signalled in bad weather to employ the Full Steam-power of her engines alone, the Screw-ship thus equipped either will not be stripped of those heavy yards, top-masts, and rigging, to the manifest obstruction of her powers as a Steamer; or else she will be stripped of them when so called on and be then re-rigged with them again; but certainly by an amount of labour which has been hitherto unknown in the Navy as a System. Either alternative being sufficient to realize disappointment and to mar success; and both being attributable to no inability either in the Ship or in the Principle she develops to fulfil the Services assigned, further than is concerned in the 'unsuitableness' of the Sail equipment provided for their performance.

On account of both requirements a low "Centre of Effort" is necessary for her Sails.

I do not here presume to submit any definite Plan by which a dilemma at once so obvious and perplexing may be escaped. I do not feel myself called upon to do so, nor is this the place to do it if I were. But as this part of the subject, as well as

those which have been before noticed, has received for an equal period an equal share of study and consideration, I may be allowed again to express a matured conviction, that an effective remedy may be found which shall sacrifice no portion whatever of the 'Sufficient Sail-power' of the Ship;—which may be made to fall into ready concert with the demand which, upon other grounds, has been made for a low 'Centre of Effort' for the canvass;—and which in operation shall consist in rendering as light as practicable all which will have to come down from aloft; by throwing the burthen of duty on that which may remain more undisturbed below. But any plan whatever which proposes to meet this and other difficulties, if it is to be satisfactory or permanent, must present the features of a System matured for its work; such as may upon trial be expected to be fit to perform it; with a moral confidence that Success will amply reconcile and justify any dissimilarity it may present to the ordinary Sailing Forms by which more ordinary Services have been hitherto effected.

I have thus set forth the difficulties which I have seen in the way of working out the great Object of the Economical and therefore General application of Steam in the Navy which the Screw was originally intended to realize; such as these difficulties must also have presented themselves to any other mind, which with equal means had also given equal time to their study and examination. I have specially defined, and specially analysed them; not with the view of submitting them as discouragements, nor with the intention of exaggerating their importance, still less under any motive of a personal nature. But my object has been to exhibit them in what I believe to be their true extent and bearings, in order that in the day of trial they may be found to present no unknown hindrances, and excite no unsound fears. I could not thus study and analyse them without equally doing so by the remedies by which they might be met; and I could not make the exposition of the one, unaccompanied by the statement

The difficulties of investing the Screw-ship with full Sail-powers set forth solely for the purpose of showing that they can be met.

of what I conceived to be the other. No doubt there may be room for sounder and more efficient remedies yet to be pointed out, and the preparation of any one of our Screw-ships for the thorough and practical testing of all the combined advantages they were designed to realise, is yet incomplete, and the day for doing so appears yet distant. But it is precisely because the day of trial is thus entirely future, I here take occasion to state, that a period of now four years constantly, and as far as possible, practically devoted to the consideration of the subject in all its bearings, has sufficed to impress me with strong convictions that unless these Screw-ships be sent to work out clear and definite Objects, after being suitably equipped upon some clear and definite System;—a system based upon known laws;—expressly framed to meet the peculiar discrepancies which have here been pointed out, and admitting of such modifications as experience will certainly show to be requisite :—unless some such course be adopted for bringing to issue so extensive an experiment as our Screw-Fleet, then, indeed, under the impression of these strong convictions I must here submit, that any measure of success which individuals among them may meet with will evidently be attributable,—and in these days it will not fail to be attributed,—to the results of happy accident and not to the effective operation of a matured and well-adjusted plan. For without such plan there is imminent hazard that the majority of them will not only miss the objects they were specially meant to secure; but will even realise a further continuance of the vexatious Disappointments, Alterations, and Expenses, they were specially meant to remove. And such plan whatever it may be, in order to give confidence to all concerned in working it out, must bear stamped upon it in legible characters, that it combines the essential qualities of being SUFFICIENT and APPROPRIATE for its purpose.

The limited
space for fuel
provided in all

It may seem superfluous to suppose that motives to Economy can require extraneous support in days such as these; when,

in order to reduce to the lowest figure compatible with her Services, the expenses of the Steamer which 'whenever she 'gets up her anchor, must also get up her steam,' — we have grouped these vessels into central positions where security and repairs can best be commanded, there to await orders for their Services and where they get up neither anchor nor steam until those orders arrive. Yet in the opening part of this paper, it was thought requisite to notice the attainment of two advantages of high importance which would give additional value to the Economy of working the 'Full-powered Screw-ship as a Perfect Sailing-ship also:' and now in the concluding part, a still more important consideration, enforcing a still stronger necessity for fulfilling this original object, forbids yet more peremptorily an omission of its notice. Involving as it seems to do almost inevitably, that our ability to work our present Screw-Fleet with Efficiency or Economy in any capacity whatever, will depend on its equipment with the originally intended Full Sail-powers.

our first
Screw-ships, a
further neces-
sity for fulfill-
ing the original
intention of
making them
Perfect Sailing-
ships.

I have already pointed to the want of fuel-space which the unusual length of boiler and unusual size of holds had occasioned in the two Frigates; and to this class it was at one time considered that this defect in providing for their requirements was confined. This is not however the case, and the proportion of one-third less fuel than that carried by the ordinary Steamer, to which the stowage of the "Dauntless" is limited, may be taken to represent approximately the smaller proportion capable of being carried also by the Ships of the whole Screw Fleet. In such case therefore, if the Screw-ship is supplied with only such a spread of sail as will give her a speed just superior to the Paddle-steamer and yet leave her far behind the Sailing-ship, it is clear that she will at once be deprived of her most general and extensive source of economical employment, that namely, of being able to execute all Sail-service at a standard of the highest Sailing-speed. It is clear, if she be thus only

partially supplied, that the Sail-speed of the Sailing-ship can only be reached by her by expending a part of her fuel in aid of her sails; and it is as clear still further that Steam-speed itself can be accomplished by her only at the cost of a full expenditure. And thus while her engines, like those of her Paddle sister, must be put into requisition for every service beyond that of mere cruising, a store of fuel one-third less than the average carried by the Paddle-steamer,—as shown by the returns—of twenty-one of our larger Paddle-vessels, must reduce the comparative value of her Services in nearly a like proportion; perhaps, with an inconsiderable saving in expense. And if this should prove to be the case, then we are threatened yet more certainly with a question for the ‘Return’ of all the Labour, Expense, and Risk, incurred by so total a change as the one we are reviewing. Since instead of possessing in their intended integrity the separate powers of the Steamer and the Sailing-ship combined; the Screw-ship if unprovided with her Full Sail-power will clearly be compelled to combine both Steam and Sail, in order to enable her to attain to the ordinary speed of the Sailing-ship on the one hand; or to work with the ordinary duration of the Paddle-steamer on the other.

But if this result does arise, it will again be imputable to no unforeseen deficiency in the Principle of the Screw itself,—to no miscalculation,—to no over-estimate of its Powers. On the contrary, it will arise solely because those Powers have been insufficiently estimated, and deficiently worked out; and the extent of disappointment it will occasion will be in proportion as the original intention of providing the Screw-ship with Full Sail-powers is deviated from, and overlooked.

The practical value of the Screw-ship with complete or incomplete Sail-power illustrated in the case of the “Dauntless.”

Let us trace back our steps then to the fulfilment of this ‘original Object,’ and let us view the same case as it would then be presented, taking the same instance for illustrating it. Let us again suppose the “Dauntless” to be supplied with the same proportional amount of Motive-power in her canvass as

is possessed by the "Thetis," and in such case the challenge may be boldly offered, that on no grounds whatever can the closest inspection of their respective elements of speed be seen to support an opinion that the rate of the "Dauntless" under sail only should be less than that of the "Thetis." And if such inspection be found to give evident promise of the speed in both cases being equal, then, for the execution of every General service at a standard of the highest Sailing-speed, no fuel whatever will be used in the Screw-frigate. To raise this standard of the highest Naval Sail-speed to the average of the highest Naval Steam-speed, a very limited expense of power, and therefore of fuel, will be requisite. Even for the execution of those 'Exceptional Services' requiring the employment of 'Full Steam Power' the expenditure will only equal that of an equally powered Paddle-steamer during the time of using it, while the frequency and the duration of those 'Exceptional Services' will be more limited than they are in her case, and Economy will be effected in this item also. Thus the 250 tons of fuel, which, when she was 'jury-rigged,' would not have sufficed the other day to have brought the "Dauntless" (in her original form) from Greenock to the Nore, would, with her 'Full-Sail Power' (presuming her to have undergone effective alteration), be a store sufficient to take her a voyage of any length, the circumstances of which might require the aid for 20 days of Auxiliary Steam-power, in order to enable her to accomplish it throughout, at the highest average of Naval Steam Speed.

PART IV.

THE NECESSITY OF OBSERVING THE ESSENTIAL DISTINCTIONS BETWEEN PADDLE PROPULSION AND SCREW PROPULSION WITH RESPECT TO EQUIPMENTS.

MORE than twenty years have now elapsed since we commenced the struggle to render the Services of our Steam-ships, General, Efficient, and Economical ; and though during that period great relative improvement has been made in them, and much valuable duty has been performed, yet to Positive success we have scarcely made approach. No wonder then, that after efforts so earnest and so extended, both those who have made, and those who have observed them, should feel a strong conviction on their minds that the attainment to Positive success is hopeless ;—that to combine in one Ship with perfect harmony and perfect usefulness for every Service, the complete powers of Steam, Sail, and Armament, cannot be done. Boys have first been educated in these convictions and their subsequent experience as men has confirmed them, and so long as the influence of these convictions is exercised within the legitimate sphere of the experience which produced them, they are entitled to every respect. Strong convictions however, which have been thus acquired within one sphere of experience, whenever it may be proposed to adopt them for another, should always at first be regarded with watchfulness in their new field of operation. But whenever it may be proposed to force their influence upon a case the reverse of that which legitimately gave them birth, wisdom and prudence alike demand that they should be at once opposed. That which Reason cheerfully assents to as the guidance of a sound judgment in the one case, she is equally compelled to reject as threatening the results of a mischievous prejudice in the other. And in the instance under consideration there exists just cause

for Watchfulness at least, if not for Opposition. There is an obvious, and important link, seeming—but in most respects only seeming,—to connect in one chain of Experience the knowledge which has been acquired in the working of a former Principle, with that which has yet to be acquired in the working of the Principle which is destined to supersede it. Never mind that in Size,—Form,—Proportions,—Position,—and all but Elementary principles,—the engine for the Screw, has, in order to effect our purposes, been made to differ *in toto* from the engine for the Paddle. There it lies; confessedly and undeniably an ‘Engine’ still; and, as I believe,—very unfortunately so,—the ship that carries it is still to be called a ‘Steamer’;—and is therefore subjected to all those unfavourable and discouraging influences and convictions, which former Experience has ever associated with that word.

To expose then, the main results of former Experience, as regards uniting the Efficiency of a ‘Full broadside Armament;’ with the Economy of constantly using ‘Full Sail-power;’ with the view to control within its own limits that portion of this ‘Experience’ which can only be prejudicial beyond them:—to show that the Screw-ship presents in every feature distinctive conditions of her own which forbid her being identified with anything constructed before her:—to show that in her case, as in that of every other new description of ship, the classification of her Sail-Powers and armament can only take place when found sufficient and appropriate for the development of her distinctive Merits; and therefore that the constituents of those Merits,—her character, position, duties, require to be distinctly defined:—thus in short to establish a sound basis no less for her defence, than for the fulfilment in their integrity of the high and peculiar Services of which she is capable—This has been the special, perhaps excusable Object, of the originally unintended length of this Chapter. An Object quickened by a sense of necessity. By observing that Mischief has already begun;—that it now

produces Perplexity, and threatens soon to bring in Confusion. For even in the two Screw-frigates the Paddle-steamer has been allowed to impose largely on the Screw-fleet the incompleteness of her own Armament: she is still engaged in reducing to her own standard the Equipment of its Sails.

Is it then proposed, it will be asked, that all our past Steam-experience must go for nothing?

Most certainly not. For in many most important points respecting the management of both ships and machinery that Experience is truly valuable; and in no degree whatever can any change be justifiable as regards the great Objects we are endeavouring to obtain. These remain now as they always have been—the same,—and we should as gratefully accept from the past whatever may assist in securing them, as we should firmly reject whatever cannot; but as regards the MEANS by which we now propose to arrive at these Objects, almost all our Experience has yet to be formed. Had ‘Former Steam-Experience’ ever led to the hope of realising for Naval purposes a Steam-ship Completely armed for every exigency of warfare; Effective in all the varying circumstances of General service; and in all her services Economical; then would no room have been found for even the proposal of superseding the Paddle by the Screw. But it is precisely because we have proved by an effort of more than twenty years’ duration that the Paddle is not an instrument with which to accomplish such results, that we now adopt the more effective means of securing them which is offered in the Screw; and it is as essential to Success to keep in mind that the Objects aimed at are in both cases identical, as it is to remember that we are employing a totally different Agency with which to obtain them.

With the further completion of that Agency we have every encouragement and inducement to proceed. Great difficulties have been overcome in preparing to complete the advantages it holds out; great expense and labour have been already

incurred in overcoming those difficulties ; and that stage of progress has now been reached in which professionally the more Naval share of the work will have to be undertaken. Skilfully has the Engineer accomplished his important portion of the task ; and well has the Constructor made provision for removing all impediment of the Screw-surface when under canvass only, as the task which his profession specially required of him to undertake.

But the Ships which have been thus prepared in the Factory and the Dockyard have yet to receive their appointed equipments in order to be perfected and proved upon the Ocean. And with example to follow, and encouragement to proceed, shall their extent of equipment alone be imperfect? Shall we now yield before Professional difficulties so long and so far less hopefully contended with under the greater discouragements of a former System ; or shall we bring to bear on them less ability, perseverance, or devotion now than then? The reward of success is no mean one ; for it is a success which will stamp with the date of its attainment, an era in Naval progress. But let the completion of the means by which that success may be secured be well and maturely considered.—

We see that the armament *can* be made to resume its wonted power, position, and completeness.

We see that the engine in full security below, *is* able to carry it through all the risks of action with every expected advantage.

That the EFFICIENCY may thus be indeed Complete.

But that ECONOMY which alone can bring this Complete Efficiency into useful and General employment in all the services of the Navy,—remains as yet undeveloped. Yet as truly is it within our grasp,—and will be realized in that day, when with a ‘ SUFFICIENT AND APPROPRIATE SAIL-EQUIPMENT,’ we elicit the high Sailing-speed now lying dormant in the fine Form and Proportions of the Full-armed and Full-powered SCREW-SHIP.

CHAPTER II.

ON SCREW-SHIPS AS COMPARED WITH AUXILIARIES.

PART I.

THE RELATIVE MERITS OF SCREW-PROPULSION AS APPLIED WITH
FULL STEAM-POWER OR WITH LIMITED STEAM-POWER.

Sail-power the
"rule," and
Steam-power
the "excep-
tion," in the
employment of
a Screw-fleet.

THE preceding pages have been devoted to an exclusive consideration of the Screw-ship as invested with Full Steam-power, and a separate and closer investigation has been bestowed upon that part of the subject, under the impression that the chief difficulties which have yet to be encountered before the principle of Screw-propulsion can be perfected as a general System for the armed Steam-Fleet of the Navy, will be found in the practical working of the Screw-ship in her double capacity as a Perfect Sailing-ship also. Such anticipations however must not be understood as having reference in any way to her machinery. It is true, indeed, that future Experience must decide for us the superiority between engines which drive by 'gearing,' and engines which drive 'direct;' and when this question of principle shall have been determined, the same tribunal will again have to decide between the various plans which illustrate that system to which the palm of superiority may have to be awarded. But although we must thus be prepared for those improvements which a more extended and watchful practice will be sure to suggest, yet the really great difficulty of constructing an entirely new class of Marine Engine, equally as powerful for propulsion as the old ones and working in a position of Security from all the risks of action, must be considered as completely met and overcome.

Not in such terms, however, may we speak of the difficulties

and anomalies which have been shown to exist with respect to the Sail-equipment of the Screw-ship; no experience of any value or extent can as yet be appealed to for the solution of these, and yet they possess an importance far beyond their own, because upon their successful solution, depends our ability to realize the full value of whatever else has been already accomplished.

The whole question of Economy resolves itself into our being able usefully to employ Sail-power as—‘the rule,’ and resort to Steam-power as—‘the exception;’ and whatever may be the improved Efficiency in armament secured by the adoption of the Screw, Economy alone will determine whether it can or cannot supply an improved System for the more General and extended employment of Steam in Naval services. In giving prominence then to that portion of these pages in which these difficulties and anomalies came most naturally under notice, and in endeavouring to point out both the necessity and the means of conquering instead of yielding to them; it was my object to convey to others the convictions I am led to entertain strongly myself, viz., that the practical value of a Screw-Fleet is to be worked out of its ‘cavass,’ rather than out of its ‘coals,’ and that the justification of the great change we are introducing, must be shown in the ‘practical economy’ which will result from taking full advantage of that peculiar property of effecting a perfect co-operation between the powers of Steam and Sail, which the Screw of all other known propellers alone possesses.

In continued accordance with these convictions I now proceed to examine the case of the Screw-ship in her capacity as an Auxiliary also; but in order that we may more clearly determine and compare the value of the services to be demanded of her under this more limited employment of her Steam-powers, I shall first endeavour to define and establish the character, powers, and duties of the Auxiliary herself; that is, of the Ship the Steam-power of which is only sufficient to enable her ‘effectively to perform every Special service by bringing to ‘the aid of her Full Sail-powers a limited use of Steam.’

The character of the Screw-ship and the Auxiliary examined by this “rule.”

The discovery
of a perfect
combination
between Steam
and Sails in
Screw Pro-
pulsion.

This part of the subject then may perhaps be appropriately commenced by observing, that to one common origin must be assigned the practical existence of Screw-ship and Auxiliary alike, namely, to the extended and successful performances carried out on our own and the neighbouring Coasts and Seas, in the years 1839 and 1840 in the "Archimedes." For it was the experience of the real practical working of the Screw first obtained during these performances, which elicited the fact, that, unlike the Paddle-wheel, the Screw when at work as a propeller—

' COULD NOT BE OVERRUN BY ANY SPEED PRODUCIBLE
' ON THE SHIP BY THE EFFORT OF HER CANVASS; AND THAT
' A PERFECT CO-OPERATION BETWEEN THE POWERS OF SAIL
' AND STEAM COULD BE EFFECTED IN ALL CIRCUMSTANCES
' AND IN ANY DESIRED DEGREE, WITHOUT ANY DETERIORA-
' TION TO THE SEPARATE AND COMPLETE EFFORT OF EITHER.*

* The first voyage ever made across the sea by means of the Screw was performed from Plymouth to Oporto and back, in August 1840 by the "Archimedes," just subsequent to her circumnavigation of Great Britain. The distance between the two ports is 650 miles, and was accomplished, out, in 68·5 hours, or at an average speed of 9·48 knots. It had been previously ascertained that the utmost speed of the "Archimedes" under steam only was 8·02 knots; and 9 knots her utmost speed under sail alone; but upon this occasion the combined effect of both powers in full operation enabled her to attain at times an extreme speed of 11·5 knots, the engines when at this speed increasing their revolutions from 25 up to 26·5 only, and the advance of the Screw through the water being nearly half a knot less than that of the Ship.

In a similar case which lately came under my own observation, the Ship under the full effort of both powers was found to be running 1·25 knots faster than the advance of the Screw, yet while keeping all sail set, and alternately applying the full or the expansive power only of the Steam, the variations in the revolutions of the engines and the speed of the ship, were quite sensible and corresponding. At one time when it became necessary to bring the ship head to wind against a very strong breeze and heavy sea, with her fore-and-aft sails not lowered but the booms lashed amidships only, the revolutions of the engines fell off to 59. When before the same breeze, they again averaged 68; so that the effect of these extreme circumstances upon the machinery was to vary its working power about one-seventh only, an amount which shows that as regards the re-actionary effect of the Screw upon the machinery, it may be considered practically, as admitting in all circumstances of the equable working of its engine.

This discovery not only revealed the true source of that economy which could be made to result from the General employment of the Screw as a Full-powered Steam-agent, but it also at once determined the practicability of employing limited Steam-power as an Auxiliary agent in the case of Ships already built; and accordingly, when further proof had been shown of the full efficiency of the Instrument itself as a propeller, it was at once proposed to make this limited application of its powers in such Ships of the Navy of appropriate forms as it might be thought desirable to equip with it; the intention being that such application should in no way interfere with their position in those respective Classes of the Sailing Fleet to which they might already belong.

The discovery then first made, has been confirmed by subsequent experience to an extent which justifies its assumption as an acknowledged Principle, and in adopting it as such on the present occasion, I shall go on to consider the case of the Full and the Partially-powered Screw-ship in their respective capacities as Auxiliaries under the assumption that both of them have been provided with complete and appropriate Sail-power; and I take this mode of treating the subject the more readily, not only because it more truthfully coincides with original views and intentions;—but also because I believe that it will simplify and facilitate the solution of all questions having regard to the powers and services of our Screw-Fleet, to consider that the primary and normal condition of ALL its several members is that of complete Sailing-ships, and that the further conditions and appointments furnished to them respectively as Steamers are therefore to be looked upon in the light of additions made to this normal state, and supplied to them,—not for general use,—but for the purpose of enabling them to execute ‘Special services,’ or ‘Exceptional services:’ according as they may have been provided respectively with ‘Full Steam-power’ or with ‘Auxiliary Steam-power’ only.

renders the normal condition of both Screw-ships and Auxiliaries that of perfect Sailing-ships.

Complete Sail-power essential to the character of the Auxiliary.

With this view of the subject the cases of the two frigates, "Amphion" and "Arrogant;" the one adapted to the Screw, the other built for it; will be seen fully to agree. Both are true Auxiliaries; that is, the Steam-power is a *bonâ-fide* addition to the already complete Sail-power; and both powers can at all times be effectively used whether separately or together without detracting from the complete effort of either. And the fulfilment of the condition here set forth appears to be essential in order to constitute the true character of every Auxiliary. First,—it seems to be demanded even by the meaning of the term itself; since if it were necessary to diminish Sail-power, as a necessary preliminary in order to supply Steam-power, the addition of the latter would be more in the character of compensation for a loss, than in that of a true auxiliary assistance; and the amount of improvement actually effected would be limited to the difference between the power which was given with the one hand, over and above that which was taken away with the other. And next,—the very fact of our possessing ships which have the ability to put forth this full co-operation of separate yet Complete powers, seems to require of us that we should make due use of it; for the economy and advantage of all such vessels over any others must certainly be based upon the extent with which they are able to employ so peculiar a combination of powers; since the Services to be rendered by its means must constitute the only mode of repayment to which we can look for the extra expenses of their double equipment; and hence complete repayment can only there be expected where the powers which are to make it are themselves complete.

The consequences of incomplete Sail-power examined in the case of the "Plumper."

But the simplest mode of exemplifying its necessary fulfilment is to examine the consequences arising in a supposed case in which this condition is not complied with. Let us take then as an instance in order to illustrate this side of the question,—say, the "Plumper," and adopt the view that such vessels

are intended to supplant in our Navy the services of its present various classes of Brigs, with which, on all points of efficiency as regards armament, they may be taken to stand upon a footing of perfect equality. But in making the "Plumper" an Auxiliary, and in providing her with a 60 Horse Power engine, we will suppose that it had been requisite to reduce her Sail-power to such an extent that it was not sufficient to enable her to attain to the same Sail-speed as the brig, save by the employment of, say, 20 Horse Power in aid of her sails. In such case it is clear that all 'General services,' that is, services performed strictly under sail alone, must be executed by her at a lower standard of effective speed than that of the class she would be intended to supplant, and, as far as related to these services, we should be substituting therefore an inferior for a superior Class of vessel. On the other hand, if she is obliged to employ the aid of Steam in order to attain that Sail-speed which the brig possesses without any such costly assistance; then it is clear, that as regards the performance of Sail-services at an equal standard of Sail-speed on both sides, we should be substituting a more expensive for a cheaper Class of vessel. And it is clear, still further, that although provided with engines of 60 Horse Power, yet the amount really available for the performance of any services whatever beyond those which could be accomplished by the Brig would be reduced to 40 Horse Power only: but still the extra services performed by this effective fraction only of her machinery, would be all we should get as an equivalent for the cost and expenses of providing and working the whole power. And without following the consequences of our supposition any further, it is evident that the true character and true value of all Classes of Auxiliaries, must depend upon maintaining their Sail-powers complete and enabling them under sail alone at least to equal the Sailing-speed of the Classes they may be intended to supersede.

While Equal Sail-speed is thus necessary on the one hand in order to avoid failure, superior Sail-speed must, on the other, proportionally enhance success. Nor does there exist any cause whatever why the Sail equipments of the ships should be appointed with any other or lower aim; since, whether their after holds contain an equal weight of 'stores' or of 'Steam-engine,' cannot possibly affect either the Sail-powers or the sailing qualities of any ship in any other way, save that in the latter case it will add to her stability. On the other hand, every improvement in the Sailing-speed of such ships must be attended with improved efficiency and economy combined; it must render the use of the Steam less frequent, and when used more effective, and as we proceed to supplant the older classes of the Navy by calling forth more extensively this new description of Ship, we shall do well to elicit from them that higher Sail-speed which their finer forms assure us they possess. In accordance with the Principles defined in former pages of this work, the simplest and most obvious course by which to accomplish this object, would seem to be that of supplying the new ship with the same proportion of Motive power to Resistances as is possessed by the one she supersedes; and when this object is accomplished, there seems little room to doubt of an ample reward from gradually filling all the more active classes of the Navy with Screw-Auxiliaries.*

The amount of Steam-power in Auxiliaries such as to render them independent of Steam assistance from others.

From this view of the necessary completeness of the Sail-power of all Auxiliaries, let us turn to consider the proportion of Steam-power, which from the character of the services to be demanded of them we may expect them to require. And

* The following comparative data, of the "Plumper" and the "Mutine," both of which are built from the designs of the same Constructor, will illustrate the application of the Principles adverted to in the case of the Auxiliary, as they were illustrated before as applying to the case of the Screw-ship. With this difference however; that the instance of the "Dauntless" shows a case of its application as it ought to be; while that of the "Plumper" shows its application to a case as it is.

Comparative

here again, First experience, when it recognised the practicability of employing a limited Steam agency in aid of the

| Comparative Data. | H.M.S. "Mutine." | H.M.S. "Plumper." |
|--|------------------------|------------------------|
| Length, extreme, upon load-water line | Feet. 102 | Feet. 140 |
| Breadth, extreme | 31.4 | 27 |
| Area of load-water line | Square Feet. 2520.9 | Square Feet. 2935.3 |
| 'Measure of Stability,' estimated as before | 83621.8 | 74740.4 |
| Area of Sails, including as before | Square Feet. 10031 | Square Feet. 8549 |
| 'Moment of Inclination' of sails | 463432.2 | 376156 |
| 'Centre of Effort' above load-water line | Feet. 46.2 | Feet. 44 |
| Area of Midship section, or 'Direct Resistance' | Square Feet. 249 | Square Feet. 239.9 |
| Area of Ship longitudinally, or 'Lateral Resistance' | 1367.8 | 1708 |
| Load Displacement, or 'Mass' | Tons. 500.5 | 647.6 |
| Area of Sail, per foot of section, or Proportion of Power to } Resistance | 40.28 | 35.63 |
| Area of Sail per ton of Displacement, or Proportion of Power to } Mass | 20. | 13.2 |
| Height of midship Port-sill above water | Feet. In. 4 10 | Feet. In. 6 8 |
| Mean load draught of water | 13 5 | 12 2½ |

With these data for calculating the proportions of 'Stability' to 'Inclination' in the two cases it appears, that the Stability of the "Plumper" is one-tenth greater than that of the "Mutine;" or practically that when the "Plumper" was heeling 10°, the "Mutine" would be heeling 11°. But it also appears that the "Plumper" requires an area of 9663 square feet of sail, or an addition of 1114 feet in order to place her on equal terms with the "Mutine," as regards the relative proportions of 'Power to Resistance;' and if this addition be made without increasing the vertical height of the Centre of Effort; that is, if it be added to her low, and not to her lofty sails, the proportions of 'Stability' to 'Inclination' would in both cases be alike.

In the case of this comparison also there is a great disparity in Displacements amounting to no less than 147.1 tons; and the fact that the "Plumper" is thus nearly one-third larger than the "Mutine," seems to demand a yet further addition to her Sail-powers. If 367 feet be added on this account, making 10,000 feet in all, and raising the proportion of 13 feet per ton. up to 15 feet per ton, against the 20 feet per ton of displacement in "Mutine," then, a reduction of 2 feet in the vertical position of the Centre of Effort of Sails in "Plumper" would be necessary, in order to maintain the *same* proportions of 'Stability' and 'Inclination' in the two cases, but if no such reduction be effected, then the 10,000 feet of canvass will show a proportional difference of 'Stability' in favour of the Brig of one-seventh, or, where the "Mutine" was heeling 7°, the "Plumper" would be heeling 8°.

This seems a difference of no great moment perhaps, even if fully realized, since in all cases of action, a reduction of sail aloft would be more than com-

Sails; suggested at the same time that the requisite proportion of Steam-power for ships thus furnished, should be that which would render them independent in circumstances in which they might otherwise require assistance for themselves, without its being sufficient to enable them to furnish that assistance to others which Full Steam-power can alone afford. In short that its extent should be fixed by reference to their own wants alone; and assuming this to be still a sound and practical principle generally, then the nature of the services in which it is to be expected that the Auxiliary of the Navy will chiefly be employed appears to afford the best indication for the requisite amount of her Steam-power. Coasting operations, and all defensive and protective Services, seem specially appropriate to the duplicate powers of all such vessels, and the chief obstacles to be encountered in their execution will be the tidal and river streams of channels, coasts, and harbours. The strength of these will of course differ in different countries and circumstances, but a Steam-speed of *less* than eight knots can hardly be expected to enable ships destined for general and foreign employment successfully to meet those they may have to contend with. The almost invariable accompaniment of such currents with strong and sudden eddies renders a full command of steerage power essential to safety; and when struggling against such circumstances it should be borne in mind, that a ship is forcing her ascent up an incline, and has to

pensated for by the effort of an engine below. But this instance of comparison seems to require a closer approach in the relative proportions of the Elements in the two cases, than was necessary in that of "Thetis" with "Dauntless;" since in this there is a difference of 1 foot 10 inches in the respective heights of deck with all the attendant weights, against the Auxiliary, and the position of her machinery is not so low by 15 inches as by referring to the drawing of her midship section it seems that it might have been. So that the difference of 1 ft. 4½ in. in draught of water in favour of the "Plumper" may be taken as requisite to counterbalance the disadvantage of the greater height of her deck, leaving the 'Stability of Form,' as ascertained by the calculation, more unaided in her case than it is in that of the "Dauntless."

contend with a certain amount of the Force of Gravitation in addition to the velocity of the stream.*

Thus the requisite Steam-power seems reduced to a question of requisite speed, and this again, as we attempt to define it into actual proportions of Horse Power to tonnage, resolves itself into a question of Form, the effects of which have been found to vary from the very remarkable case of the "Adonis," in which a proportion of one Horse Power to every 11·3 tons of measurement, gave when tested, a Steam-speed of 9·38 knots per hour; down to the case of the "Ajax," in which a proportion of one Horse Power to every 3·9 tons gave a Steam-speed of 6·45 knots only; in the latter case no adaptation in the Form of the ship being provided for the mode of propulsion employed, while in the former case the ship was carefully built for it. And although variations in speed due to differences in Form must always be expected to occur, and even unfavourably so in instances in which it may still be very desirable to adapt the Screw into ships not originally designed for it; yet sufficient experience already warrants the expectation that whenever the Screw is used in an appropriate Form of

In well-formed ships an amount of 1 horse-power to every 8 tons may be deemed sufficient.

* The circumstances attending the trial of Her Majesty's Ship "Ajax," in December last, will serve to illustrate both these points. On her return into Portsmouth harbour, after having had her speed tested before the 'measured mile' in Stokes Bay, the revolutions of the engines of this Ship were permitted to fall from their maximum of 41 down to 37, and although assisted by a Steam-tug, and with a fair but light wind, the ship was unable to stem the spring ebb-tide, but continued going astern for a period of about half-an-hour during which the steam was rising to its full strength. The "Ajax," therefore, when fully stored, armed, and rigged, could not without assistance be expected to force her passage to sea against the strength of a spring tide and a fresh breeze blowing into Portsmouth harbour; however urgently her services as a Steam Guard-ship might be required outside.

Again, the falling off of the four revolutions of the engines should have reduced the speed of the "Ajax" from 6·45 to 5·82 knots, and from the known rate of tide at the entrance of the harbour, this would have sufficed with the assistance which she otherwise received to enable her to stem it, had she not been contending also with the gravitation due to the inclined surface of the water.

vessel whether casually found or especially provided for it, a proportion of one Horse Power to every eight tons of measurement will give an approximate Steam-speed of eight knots.

As I here close the more theoretical view of the character of the Auxiliary, we will now examine shortly in what respects the case of the Screw-ship in this same capacity also can be seen to differ from it; and in order to do so the more concisely in this and in all subsequent comparisons of the same nature, I shall adopt the above proportion of one Horse Power to every eight tons as the practical standard for the Auxiliary; and the proportion of one Horse Power to every two-and-a-half tons as that for the Screw-ship.

As a first point of comparison, then, it will be observed, that whether provided with the larger or the smaller of these proportions of Power, the machinery in both classes of Ship is alike placed in a position to afford its aid with perfect security in time of action; and that it is alike unobstructive to the free use of that complete broadside battery with which both classes alike are capable of being armed.

Next,—we have throughout assumed that the Screw-ship and Auxiliary are equally furnished with a full and appropriate Sail-equipment as the normal condition of both alike.

And lastly,—in order that this Sail-power may have its full effect according to their respective forms, both classes have been equally provided with the means for removing the Screw out of water whenever under canvass alone.

From this complete similarity in all the important features of their equipment it therefore follows, that both classes in due proportion to the power of their respective armaments and crews, can be alike prepared to fulfil the original intention of—‘effectively performing every General service under sail alone.’ In due proportion to the merits of their respective Forms, both can be alike prepared for—‘effectively performing every Special service, by bringing to the aid of Full Sail-power a limited use

of Steam,' which limited amount it is clear may in both cases be applied in the same proportion. And the differences between the two classes therefore up to the point of comparison we have here arrived at will stand thus.

That in addition to the proportion of one Horse Power to every eight tons of measurement furnished to the Auxiliary to enable her to execute 'Special services' only; there has been furnished to the Screw-ship a further proportion of one Horse Power to every two and a half tons, as a reserve with which to enable her to execute 'Exceptional services' also. And as the effective performance of these Services must require in her case a frequent transition from Perfect Sailing-ship to Perfect Steamer, and back to Perfect Sailing-ship again, so her Sail-equipment must exhibit an arrangement intended to facilitate such transitions, and may therefore be expected to be different in mode—not in amount,—from that of the Auxiliary. If indeed it be not hereafter the case that Auxiliaries, when purposely built for Screw-propulsion, shall be seen so much to resemble the Screw-ship in their proportions, that a common mode of Sail-equipment may perhaps be found the most effective plan for both.

The difference between the Screw-ship and Auxiliary according to the foregoing views.

I now proceed to show what further differences than those thus pointed out may be expected to present themselves, as we turn from the theoretical to take a more practical view of the respective services of these two new and important classes of Ship; but as the records of the Navy supply as yet no data of sufficient extent to enable us to define the practical value of the Auxiliary by their means, the sister Mercantile Service has been had recourse to; and I beg to express my obligations to James Laming, Esq., for his kindness in furnishing me with an accurate return of the Services of the Auxiliary vessels of the Company of which he is the Managing Director, for the entire year 1847; out of which vessels I shall select for the purposes of this present illustration, the two which are furnished

Further practical differences

with the assumed standard proportion of Auxiliary Steam-power.

illustrated by
a comparison
between the
Merchant
Auxiliary

From these returns then I find that the "Lord John Russell" and "Sir Robert Peel" of 320 tons and 40 Horse Power engines each; built of suitable forms, for general trade, from similar lines, and with similar engines; performed together 89 voyages during the above year between London and the ports of Holland, crossing the North Sea with full cargoes, and making good their passages in every state of weather without accident or delay. The actual distance thus made good was 45,548 miles; and the practical result of this instance of the well-applied combination of Sail and Steam, gives an average Speed throughout the year of 8·25 knots per hour; which has been found closely to agree with the speed of these two vessels under Steam only, as ascertained when first built and tested in smooth water, before the 'measured mile' in Long Reach.

Now perhaps the simplest way of comparing the ability of the Screw-ship when using only the auxiliary proportion of her Steam-power, to equal this high result of actual Auxiliary performance, is to suppose that these very same two vessels, during the very year, and therefore under the very circumstances in which they realized it, had themselves been using the auxiliary proportion of 40 Horse Power out of Full-powered engines amounting to 128 Horse Power, with which, in accordance to the assumed standard proportions, we will suppose them to have been furnished. No doubt such a supposition would be a disastrous one for the merchant, since the unemployed amount of power, besides its original cost, would have been occupying the space of profitable cargo. But as regards the actual result in average speed; what difference have we the warrant of experience for saying should have been shown at the year's end, between the real case and the supposed one?—One, and one only: namely, that the same 'average Speed' must have been produced in the supposed case as in the

real one, but that it would have been attended in the supposed case with less expenditure of fuel, than in the real one, and this reduction in expenditure of fuel would have been just in proportion as the Expansive action of Steam can be more economically developed in engines of 128 Horse Power, than it can in engines of 40 Horse Power only, all other circumstances being alike.

In order to apply then the data and its deduction thus furnished by the Auxiliary of the Merchant Service to the case of the Screw-ship of the Navy, let us take again for its illustration the instance of the "Dauntless;" and examine the grounds upon which we may or may not expect an equally high result to be realized from that ship when working as an Auxiliary only, and therefore when employing only the auxiliary proportion of 182 Horse Power, out of the full-powered machinery of 580 Horse Power with which she is furnished.

and H.M.S.
"Dauntless."

The first point of comparison then will be with respect to Form; and whenever the "Dauntless" shall be as effectively altered in this important respect as all her other sister Screw-ships already have been, we have no reason whatever to think that her Form will prove in any degree less suitable for Screw propulsion, than those of the merchant vessels with which we are now comparing her; and therefore under an equally proportioned application of Steam-power we have no reason whatever to expect any other than an equally favourable result in both cases. The next point will be as regards the amount of Sail-power, and here, as well as in the means of handling it, the advantage will clearly be on the side of the Frigate, and a more effective Sail-speed must be expected from the larger than the smaller Ship especially in all Ocean work. If therefore this comparison into the practical and relative working of the Auxiliary and the Screw-ship be admitted as sound, then it follows, that from the employment in Auxiliary proportion of the combined powers of Sail and Steam in the two classes respectively,

we have a right to look for an equal 'average Speed' from equally suitable forms, whether they be those of Screw-ship or of Auxiliary; but that from the Screw-ship, we have the further right to expect that this equal Speed will be produced by a smaller expenditure of fuel.

To what extent this latter expectation may be realized, can alone be determined by actual experience in each individual case, according as its circumstances and the mode of management may vary; but in order to afford some practical data for an approximate estimate I may here observe, that if the hourly expenditure of fuel used by the "Dauntless" when under Full Steam-power on her passage to Portsmouth, be reduced by one-fifth as the saving to be effected when using her steam expansively, then an expenditure of 12 tons per day may be stated as the probable consumption required for her auxiliary proportion of 182 Horse Power; and in such case the 250 tons taken on board in the Clyde would have been a supply for her use as an auxiliary as before stated, for 20 days. And the 350 tons she is calculated to stow, would, by the same estimate, become fuel for 28 days' auxiliary use; and it might therefore be considered as sufficient to take the "Dauntless" from Portsmouth to Calcutta direct at the highest average of Naval Steam-speed, provided that no demand were made for the employment of her Full Steam-power during the passage.

The result of such comparison shows the Screw-ship to be equally efficient and more economical in her Auxiliary Services than the Auxiliary herself; both being equally equipped in all but Steam-power.

In the absence therefore as yet of any extended and real experience by which to establish the relative characters and services of the Screw-ship and Auxiliary of the Navy, it has been thought right that the most extensive and ably-worked system of experience afforded by the Merchant Service should be appealed to; and if the reasoning based upon the facts which it supplies be at all valid, then, while waiting for actual experiment to decide to the contrary, it must be allowed to prove that even in the exercise of her Auxiliary powers *only*, the Services of

the Screw-ship must be regarded as being equally Efficient, and yet more Economical than those of the Auxiliary herself.

THROUGHOUT these pages the duties to be executed by the several members of our Screw-Fleet in their respective capacities as Auxiliaries, have been designated as 'Special services,' in order to distinguish them from those duties requiring Full Steam-power on the one hand, and those requiring Sail-power alone on the other; and it has been more than once put forth that we may expect these 'Special services' to be performed in all cases of the fair application of conjoint Steam and Sail, at the highest average of our present Naval Steam-speed.

The limited use of Steam in both Screw-ships and Auxiliaries, capable of giving the same "mean rate" as is now realized in the Full-powered Paddle-steamers.

Now it is willingly admitted, that as an agent of communication across the Ocean, a ship of whatsoever description is within the sphere of her operation essentially a Locomotive; and therefore that like every other agent to which the term applies, the main proof of her comparative value is that which is supplied by ascertaining her 'average Speed,' or the mean rate at which she performs her work, which 'average Speed' becomes therefore the comparative standard for the 'Duty of the Ship.' It will be objected therefore that to speak of 'Special services' being performed at the highest average of Naval Steam-speed, is equivalent to saying that the Screw-ship when using her Full Sail-power assisted with only a limited use of Steam, can be expected to realize the same 'mean rate,' or exhibit the same 'Duty of Ship,' as our present Full-powered Paddle-steamers now do. And this, as applied to Services sufficiently extended to furnish in both cases a truthful average, is in reality what I have meant to put forth.

But as this position may perhaps be considered to require some support, I shall now adduce, with the view to substantiate it, a few of the highest 'average Speeds' of Full-powered Paddle-steamers which have been as yet accomplished on the Ocean, in order that they may be compared with the performances of the Auxiliary vessels I have above quoted; these

This position supported.

performances being assumed as the standard, which I have endeavoured to show may reasonably be looked for in all cases in which an equal proportion of power to tonnage, is equally well applied, to equally suitable forms.

By the kindness of Mr. Cunard, I have been furnished with the performances of the two fastest of his first line of mail packets from Liverpool to Halifax for a period of two complete years; and I find that in 1846 and 1847, the "Cambria" and "Hibernia" made together 44 voyages out and home, running over a distance of 112,400 miles, and showing a mean rate or 'Duty of Ship' of 9·16 knots per hour. These are vessels of 1353 tons, and 510 Horse Power, or with a proportion of one Horse Power to every 2·65 tons.

By the kindness of Captain Chappell, R.N., I have been furnished with the Ocean performances of the ships of the Royal Mail Company from Southampton to Bermuda, Barbadoes, and St. Thomas's, for the year 1848, and I find that the several ships of the Company employed on these lines, have together run over a distance out and home of 146,383 miles, and show a mean rate or 'Duty of Ship' of 7·65 knots per hour. These are vessels of 1300 tons and 400 Horse Power, or with a proportion of one Horse Power to every 3·25 tons.

Of armed vessels, the "Terrible" has been selected for comparison, because she is the most powerfully equipped Paddle-steamer in the Navy, whether in Guns, Engines, or Sails; and after carefully rejecting all distances performed when towing, when cruising, or when disabled in machinery, I find from the Special reports of the "Terrible," that she performed in 1846, 1847, and 1848, a distance of 15,731 miles, and shows for this period a mean rate or 'Duty of Ship' of 6·83 knots per hour. This is a vessel of 1847 tons and 800 Horse Power, or with a proportion of one Horse Power to every 2·31 tons. But it must be observed with regard to the armed Steamer, that unlike the sister ship in Mail employ, she is required for the

sake of economy to use her canvass whenever possible, and of the whole distance completed by the "Terrible," 6,277 miles, or 40 per cent. of it was performed under sail alone.*

Now, we have seen that the two Auxiliary vessels which have been quoted as standards performed 89 voyages in the year 1847, making good a distance of 45,548 miles, and showing a mean rate or 'Duty of Ship,' of 8.25 knots per hour.

* The following analysis of the concise special reports of the performances of the "Terrible," seems to corroborate the view that the fullest amount of canvass which can be supplied to any Paddle-steamer, can never be expected to co-operate with the Steam-power, so as to produce an improved speed in her general employment. But that the economy of fuel to be derived from a frequent use of the sails will always be attended with a proportional reduction in the mean rate, or 'Duty of the Ship.' In other words, that improved economy derived from the general use of canvass in the Paddle-steamer, will always be realized at the expense of reducing her efficiency.

The first Report relates to services performed on our own coasts and in the Mediterranean, between the months of March and October, 1846; and deducting all performances which do not give the fair speed of the ship it supplies a distance of 5725 miles, and shows a 'Duty of Ship' of 9.07 knots per hour. 351 miles, or 5.92 per cent. of this distance, was performed under sail only, and the 'duty' of each ton of coals for the period during which the engines were at work, was 4.35 miles.

The second Report relates to a passage from Lisbon to Loando and back again, made in July and October, 1847. Making the same deduction as before, it supplies a distance of 7975 miles, and shows a 'Duty of Ship' of 5.68 knots per hour. 4748 miles, or 59.53 per cent. of this distance was performed under sail only; and the 'duty' of each ton of coals was 4.69 miles.

The third Report relates to services in the Mediterranean, extending from January to October, 1848, after receiving an increased establishment of masts and yards. It supplies a distance of 1834 miles, and shows a 'Duty of Ship' of 7.08 knots per hour. 1178 miles, or 64.23 per cent. of this distance was performed under sail only; and the 'duty' of each ton of coals was 5.34 miles.

All these Reports go to show the Sail-power to have been always used in the "Terrible," separately from, not in combination with the Steam; and in calculating the 'duty' of each ton of coals, or in other words, the 'Duty of the Engines,' I have of course excluded the distances performed when the engines were not at work. But with the view to ascertain the saving in coals, corresponding to the reduction of speed, if we divide the several distances run, by the total fuel consumed in each period of running them, we shall then get—

| | |
|-----------------------------|---------------------|
| For the First Report . . . | 4.68 miles per ton. |
| For the Second Report . . . | 11.7 ditto. |
| For the Third Report . . . | 14.48 ditto. |
| And for the whole distance | 7.53 ditto. |

These are vessels of 320 tons, and 40 Horse Power, or with a proportion of one Horse Power to every 8 tons. And in corroboration of this result I will add, that in the same year, in the same trade, and belonging to the same owners, the "City of London," and "City of Rotterdam," performed together 86 voyages, making good a distance of 35,432 miles, and showing a mean rate or 'Duty of Ship,' of 7·9 knots per hour. These are vessels of 270 tons and 30 Horse Power, or with a proportion of one Horse Power to every 9 tons.

Granting therefore, that this 'Duty' of the Auxiliaries represents the 'Duty' which may fairly be expected under equally fair circumstances from the 'Special services' of the Screw-fleet, then the comparison here made goes to substantiate the position put forth thus—

Firstly.—In the case of the two fleetest of the older Ships of the Cunard line, there is a difference against the 'Duty' of these 'Special services' amounting to 11·03 per cent.*

Secondly.—In the case of the Royal Mail Ships there is a difference in favour of these 'Special services' amounting to 7·84 per cent.

And Thirdly.—In the case of the "Terrible" there is a difference in favour of these 'Special services' amounting to 20·64 per cent. This Ship having been selected for the causes before assigned as being at least a fair exponent for the average 'Duty' of our present Naval War Steamers.

In thus bringing the performances of these Auxiliary vessels into comparison with those of different classes of Full-powered Paddle-steamers, it seems right to state, that the results of a voyage just performed by the "Sir Robert Peel" from Liver-

* The mean speed of the Auxiliaries is calculated upon the actual distances between the Custom-houses of London and the respective ports of Holland as completed in so many voyages, and it does not include the traverse of the vessels which is very considerable, since the course across sea is that of a Sailing-ship throughout, especially with adverse winds; and an allowance of one knot in nine on this account would raise their mean speed up to that of the Cunard ships.

pool to Constantinople and back to London, show her mean rate to have been reduced from 8·25 to 7·05 knots per hour upon the whole distance of 6200 miles; and this result would seem to indicate that when employed in ocean work, the average speed realized in the North Sea cannot as a standard be absolutely maintained, or at least not by vessels of so small a size. This ocean voyage, however, is a first, and a winter one, and has already suggested the means of much improvement; but taking the result of it as it here stands, it shows a practical equality with the results shown even in the latest and most favourable of the three reports of the "Terrible," and compared with the general average of that ship it exhibits a difference which still amounts to 2·78 per cent. in favour of the Auxiliary: and even this comparison must therefore still go to support the position I have put forth, viz., that the 'Special services' of our Screw Fleet, that is, services performed by its several members, whether Screw-ship or Auxiliary, when assisting their Full Sail-power with a limited use of Steam, may be expected to be performed at the highest average of our present Naval Steam-speed.

But if the 'mean rate,' or 'Duty of Ship,' shows thus favourably for the relative Efficiency of these 'Special services,' even yet more strongly does the distance carried by each ton of coals, or the 'Duty of the Engines,' testify to a superior Economy. Limiting the comparison on this point to the case of the "Terrible," the 'Duty' of her engines for the whole distance—steamed,—amounts to 4·54 miles per ton, while in the two standard Auxiliaries it amounts to 29 miles per ton; and again this is corroborated by a 'Duty' of 29·87 miles per ton in the case of the two smaller vessels quoted. So that we have a difference in 'Duty of Engines' in favour of these 'special services' amounting to no less than 538 per cent. as compared with the results produced in the "Terrible;" and if we allow the 'Duty' to be taken for the distance—sailed,—

Both Screw-ships and Auxiliaries when using limited Steam-power far more economical than the present Paddle-steamer.

as well as steamed,—as shown in the note with respect even to the “Terrible’s” third and most favourable report, the difference will still amount to upwards of 100 per cent. in favour of the economy of the Auxiliary application of Steam Power.*

Nor is it with the Paddle-steamer alone that a favourable comparison in efficiency and economy may thus be instituted; but I may here add, that the performances which I have thus assumed as an approximate standard of Auxiliary speed, have been carefully compared with those of several fast-sailing Schooners belonging to the same Company, and for many years employed in the same trade, between the same ports; and that this comparison shows that the number of voyages made by the Auxiliaries has been as 4 to 1 to the number of those made by the Sailing-vessels in the same time, and moreover that the current expenses per ton per voyage of working the two different descriptions of vessel, were—reduced—in the case of the Auxiliaries, in the proportion of 16 to 25.

The advantage of thus gradually employing Screw-ships and Auxiliaries in all but the larger Classes of the Navy.

It would be beside the purpose to speculate here upon any particular mode or sphere of employment by which advantages thus realized by private energy, may with like management and in like cases be made available for the Public Service; but if results even approximating to these shall be found generally attendant upon well-applied and well-worked instances of the principle of Screw propulsion; and if the experiment now being carried out in the “Arrogant,” be found to show still further, that as regards most superior advantages in time of action, the 50-gun Frigate which has Sail-power alone, can stand no chance before the 50-gun Frigate which has Steam-power also; then may we reasonably expect that a further and well matured development of this Principle, so as gradually to

* It may be well to observe, with reference to this high economy of the Auxiliary application of Steam through the Screw, that although not at all times carrying sail, yet that the engines of the vessels quoted are always at work, under every circumstance of weather, throughout the entire voyage, and at their *Full power*.

furnish the more active classes of our Fleet with an extended reinforcement of Screw-ships and Auxiliaries, must be attended with absolute improvement both in the efficiency and economy of the whole General Services of the Navy. But specially does this seem to be the appointed mode of supplying Steam-aid to our squadrons employed on Foreign Stations ; and in contemplating the extension of such advantages it is a matter of no mean satisfaction to know, that so long as adherence to its true and original principles is faithfully observed, it may be carried out however largely, without fear of detracting, in any degree, from the high character in practical Seamanship of either our Officers or our Men.

PART II.

THE IMPORTANCE OF THUS DISTINGUISHING BETWEEN THE
CHARACTERS OF SCREW-SHIPS AND AUXILIARIES.

The superior
sphere of Ser-
vices capable
of being per-
formed by the
Screw-ship

I HAVE thus endeavoured to trace out and define the characteristics which the Auxiliary may be expected to assume in the ranks of the Navy, and to ascertain as far as practicable from actual experience the nature of the Services to be expected from her; and while assigning to these Services no more, I believe, than their true value, it has also been my hope and intention to establish in their just estimation the true position, powers, and expected Services, of the Screw-ship also. No doubt that of these two modes of employing Steam-power through the agency of the Screw, the more limited one admits of a more general and therefore a more useful development whether in the service of the Merchant or the Crown; and no doubt as we proceed to strengthen the ranks of the Navy with Auxiliaries, and thereby increase the number of ships rendered independent of the necessity of seeking Steam-aid from others when in difficult circumstances, that so the necessary number of our Screw-ships may be expected in a limited proportion to decrease. But the time cannot now, if ever be contemplated, when all demand for those Services which Full Steam-power alone can execute shall cease; and so long as the contingencies inseparable from the active duties of our Fleets shall compel them to look for the aid of Steam, so long must our Fleets comprise within their ranks Ships furnished with the sufficient Steam-power to enable them to afford it.

The towing of heavy line-of-battle ships into action, or out of action, with fleets, or against fortresses: the assistance which must be afforded to those which from time to time may

be disabled or endangered by the accidents of war or weather : the taking of large convoys, or the conveying of heavy transports into port, or out of port, through channels, or up rivers, during operations of critical emergency, or in the struggle against adverse winds and tides—These, and numerous other essential Services unnecessary to specify are such as cannot be undertaken by the Auxiliary ; it must suffice for her that when she finds herself in such circumstances, she is also found provided with an amount of Steam-power which will make her independent of the necessity of seeking aid upon her own account. It is the Screw-ship with her Full-powered engines furnished to her for the express purpose of enabling her to meet such demands, which in these cases of emergency can alone be relied on to afford material assistance to others ; and while endeavouring to establish therefore the full merits of the Auxiliary, it has also been my desire to show that in the powers of the Screw-ship to perform for us a yet higher order of Services, we must recognize her fair claim to a yet higher share of consideration.

In recapitulating what those Powers and Services may be expected to be, I will again repeat with respect to the armament of these vessels. First;—that now that we have been enabled to remove from the broadside and extremities likewise every impediment connected with machinery in time of action ; and now that the engine itself has been placed in a position of perfect security below ; *there no longer exists any reason whatever why the effective armed force of the Screw-ship should not be made to equal that of any Class of single-decked Ship, whether Auxiliary or Sailing-ship only, the Services of which she may be intended ordinarily to execute.* Provided always that such power of armament be of course calculated for in the original plan of her design, and therefore that it be not allowed to interfere with the requisite displacement which must also be provided for the weights attendant on Full-powered machinery.

Wherever in the future construction of these ships such necessary conditions are *maturely* fulfilled we may always expect to find the Screw-ship a vessel of great length, and this great length it has been before observed, offers in the case of the Screw-Frigate a clear extent of platform upon her upper deck, superior to that of either Sailing-ship or Auxiliary for the effective working of a powerful Shell-gun battery.

Next ;—with respect to Sail-power, we have seen that her true normal condition requires in this particular a complete and independent equipment ; and possessing as she does a Form superior to that of any present Class of Sailing-ship, it may reasonably be expected that, when thus equipped, all her Sail-services will be performed at the highest standard of our present Sailing-speed.

Next ;—with respect to the use of only a limited proportion of her Steam-power, we have substantiated her claim to be able to employ it with a result equal in efficiency and superior in economy to that which is expected from the Auxiliary herself. And, as respects the employment of her Full Steam-power ; since the use of only its Auxiliary proportion will enable her, like the Auxiliary herself, to execute all 'Special services' at the highest average of our present Steam-speed ; so the overplus must be regarded as the reserve to be called forth to meet the demands of 'Exceptional services' alone ; and her efficient performance of the heavy duties which were above pointed out as comprised under this term, must be taken as full repayment for the expenses of providing the necessary machinery with which effectually to accomplish them.*

* This view of a supposed division of the Full Steam-powers of the Screw-ship, by using only an Auxiliary proportion for 'Special services,' and reserving the whole amount for those which have been distinguished as 'Exceptional ones ;' when it is taken in conjunction with a peculiarity in the practical working of the Screw itself, may perhaps be made to indicate in some degree the amount of power which the larger classes of these ships may require ; and seems to justify an expectation that it may not be necessary to furnish them with the same high amount of Steam-power which the Paddle-steamer now requires for such heavy work. For instance, the 800 Horse Power engines of the "Terrible" may be

If therefore, this is no more than a just summary of the expected powers and performances of the fully-appointed Screw-ship, it then would perhaps be difficult to contemplate any mode of applying the aid of Steam in furtherance of the general Services of the Navy, more effectual in itself or more capable of economical employment than that which she is seen to present; and in making a close examination of her case as compared with that of the Auxiliary, I have expressly desired to establish her claim to that just estimation which there has seemed to be a disposition to withhold from her. For the opinion has been widely circulated, and largely received; that although truly valuable as an Auxiliary, the Screw is unable to maintain its pretensions as an useful agent when employed with Full Steam-power.

constitutes her the most valuable means of adapting Steam-power to Naval purposes.

It is not necessary to inquire whether the spread of this opinion has or has not had its origin in feelings of misapprehension and mistrust only; nor whether it can or cannot be identified as a link in that course of opposition, which however natural in itself, has nevertheless throughout all the past stages of this invention, very greatly retarded in one way or other the public recognition of its practical value.—A course of opposition which

The supposed inferiority of the Screw-ship to the Auxiliary a serious error.

taken as not at all too large for the effectual performance of the duties which have been specified above; because when towing, or contending with heavy weather, or employed in any other services which impose increased resistance on the paddle-wheels; these, react again upon the engine, and have the effect of materially reducing its revolutions and therefore of reducing its power in the same proportion. But the Screw when employed in like circumstances, is found to be affected by them in a very small degree only, and therefore the reduction of the power of the engine by the reactionary effect of the propeller is also very slight. So that, when employed in like circumstances of severe work, the evidence of the 'Indicator' might be expected to show that the 580 Horse Power engines of the "Dauntless" are capable of putting forth an effort, equal or nearly so to the 800 Horse Power engines of the "Terrible;" and if this be found to be the case, then the "Dauntless's" amount of power would give an indication of the maximum size of engine required in the largest Screw-ship, in order to enable her to perform with the same efficiency as the "Terrible," all the heavy duties for which it would have been provided.

began with a bold denial of the powers of the Screw altogether ; which then stated that it must render the ship unmanageable, because it would not back her astern ;—which then maintained that it must destroy her steerage power ;—which then asserted its incompetency to enable her to contend with heavy weather ;—which then alleged its ruinous expense ;—which then discovered a supposed inability to employ the Expansive action of steam ;—and which it may be, is now engaged in applauding its Auxiliary use, in order the more effectually to condemn its Full-powered application ; forgetful that such a position is capable of self-refutation ; and not seeing that it actually is refuted by the fact, that in several cases in which it is thus approved of as a supposed Auxiliary application, it is in reality being employed with a proportion of power larger than that of many Full-powered Steamers even in the Navy. But whether the opinion in question has originated only in misrepresentation, or in misapprehension, its adoption appears to be very extensive : and as its practical effects if developed must prove very perplexing if not disastrous, it has been thought quite important enough to warrant the attempt to overthrow it, and quite consistent with the nature of this work to show that it is totally unsupported by any single recorded fact. But in dealing with it I have been studious to confirm that sounder portion which awards to the Auxiliary no more than her just merit, and only to controvert that erroneous portion of it, which, as it directly denies the value of the Screw when employed with Full Steam-power, must, if ever acted upon, have gone to deprive us of the yet higher order of Services which it has been my object to prove that the Screw-ship is so well adapted to render.

The supposed inability of the Screw-ship to employ Sail-power as effectively as the Auxiliary another serious error,

Again, the power of usefully combining the action of Steam and Sail is often to be heard adverted to as if it were a peculiarity possessed by the Auxiliary alone, and as if it constituted the distinction between herself and the Screw-ship ; which in such cases is identified as it were with the Paddle-steamer,

and like her is considered as being dependent upon her machinery alone for the performance of all duties except perhaps that of cruising. Now the essential and distinguishing error of this view or opinion of the subject consists in its entire oversight of the fact, that the great practical value of the Screw has always been, and still continues to be based on its peculiar ability to effect a perfect co-operation with the Sails in all circumstances of employment and in any required degree; *whatever may be the amount of Steam-power with which the Ship is furnished.* And as the practical effect also of this error, if acted on, must realize great disappointment and must specially mar the Services of our present Screw Fleet, provided as all its members are with a very insufficient store of fuel to bear the stress of work which this error contemplates for their machinery; so to remove the misapprehension which this opinion embodies has also been an object throughout the comparison here instituted between the two classes of Screw-vessels. And which I now close by adverting to two circumstances, strongly substantiating and confirming the position put forth in these pages; namely, that the Normal condition of both Screw-ships and Auxiliaries alike, was always intended, and must still be considered to be, that of 'Perfect Sailing-ships.'

Prior to the days of the "Archimedes," the Screw as a propeller was unrecognized as a practical invention, every previous endeavour to apply it to the general uses of Navigation having only failed in showing it to be practicable for such purpose, and the period of the performances of that ship therefore, must be allowed to fix the date of its practical origin. Now the directions given to the Constructor who designed this First ship which successfully developed the real powers and properties of the Screw were, that all intention to employ a Steam-engine in her should be left out of consideration, and that in Form and Proportions she should be designed as if for a Sailing-ship only,—but one which was intended to realize the

refuted by all
past sound ex-
perience of
Screw Propul-
sion.

highest Sailing-speed. On this original view of the mode of employing the agency of the Screw the "Archimedes" was accordingly built, rigged, and continuously worked, and the only alteration suggested in her original Sail-equipment by her practical performances at sea was, that as a 'complete Sailing-ship' her spread of canvass might be advantageously increased. Now the "Archimedes" was not an Auxiliary, except in so far as every ship may strictly be said to be so which possesses an equipment of separate but complete powers capable of unimpaired co-operation; but in the accepted meaning of the term as here used, the "Archimedes" being a vessel of 240 tons and 80 Horse Power, or with a proportion of one Horse Power to every 3 tons,—was a Full-powered Screw-ship. Nor was the original view of the true normal condition of the Screw-ship which was thus taken by the practical Inventor of the Instrument itself, and which was so successfully realized by him in the performances of the "Archimedes" in 1839 and 1840, limited to himself alone; for the "Archimedes" was the property, not, of an individual, but of a Company, and this original view was held alike by all the other parties who thus share in the merit of assisting to develop the Invention, and the estimate of its value as entertained by all the leading members of the Company always was and still is based upon the very grounds I have set forth.

Thus there is now before me the copy of a memorial presented in January, 1846, to Sir Robert Peel, then the Prime Minister, on the part of this Company, and the prayer of the application is for the grant of certain public moneys to be given to the applicants, to be shared in certain agreed proportions by them and by four other gentlemen who together with the Inventor were more or less interested in Screw-propulsion, in compensation for the common surrender to Government of their respective patent rights to sundry forms of the Screw-propeller, this proposed surrender being made

with the view to its being thenceforth thrown open to the general Services of the country without restriction. This application was made after long and expensive litigations had failed to establish an exclusive right in any of the patentees interested in its presentation, and the amount of remuneration sought for was based upon an estimate made from the Official returns of the Steam Navy, which showed that the annual expenses of working 10,000 Horse Power machinery with the Paddle, amounted to 250,000*l*. This was accompanied by another estimate which showed that the working of 10,000 Horse Power machinery with the Screw, would effect a saving on those annual expenses to the amount 125,000*l*., or to the extent of one-half; the alleged grounds for such saving being, 'that as the Screw Steamers would be Fully-rigged Sailing ships, every General service would be effectually performed by them under sail alone.'

CHAPTER III.

ON THE PECULIAR RECOMMENDATIONS OF THE
SCREW FOR MAIL CONTRACT SERVICE.

A reasonable
and an unrea-
sonable oppo-
sition to pro-
posed "Im-
provement."

TOWARDS the close of the last Chapter I permitted myself to specify the several charges of inability from which the Screw has had to defend itself from time to time since its introduction into the Navy; and I took occasion to express regret that this mode of meeting a proposed Improvement should have had the natural effect of creating mistrust with respect to it, and preventing its distinctive merits from being seen and studied more generally than they have been. There is no doubt that to this mode of expressing continued disfavour, we are justified in imputing that delay in reaping the advantages which the construction of a Screw-Fleet in 1845 had been expected and intended to secure. But it must not be supposed that in pointing out such circumstances of regret I have intended to convey, that a want of observing the essential and practical distinctions between the Screw and the Paddle-wheel has been in any degree limited to the Navy. On the contrary, I am fully aware that unfavourable influences and discouragements have been employed against Screw propulsion, just as importunately from without our ranks, as they have ever been from within them. And with at least an equal effect in producing generally a mistrust, and in preventing generally a realization of the objects of advantage, which nevertheless, the Screw is able, and is still destined to confer. And this I feel that I can afford to say without in the slightest degree assuming thereby to cast blame any where; because all this may be seen to have a common

origin, in a common difficulty, to control within due bounds certain common feelings in us all. Wherever a proposal may be made for effecting changes in established interests, or in professional convictions and practices—never mind with however clear a proof of improvement to some—there jealousy and opposition, to a greater or less degree, will always be sure to be alarmed in others ; and the more extensive the changes, and the larger the interests involved, the more certainly mere alarm will, in due time, become a struggle. Nor, when controlled within due limits, can we even wish that it should be otherwise, for jealousy and opposition in such cases have a very legitimate and very important sphere of exercise. They are our safeguard against imposture or empiricism. And they constitute the chief security that whatever changes are indeed effected, especially in so close-packed a social fabric as ours, shall be effected by the operation of improved Principles alone.

But whenever improved Principles may have fairly established their claim to consideration, by the test of sufficient and practical proof of their value ; then, a legitimate opposition will at once give place to a wise encouragement : for any persistence in opposition, after such proof shall have been fairly given, may always be expected to entail, sooner or later, a self-inflicted punishment. To what extent the embarrassments, and delayed advantages, which have attended the progress of Screw propulsion in the Navy, may constitute our share of this self-infliction, I will not presume to define ; because I prefer to rejoice in the general feeling that the time has come when duty and interest alike require us to study the encouragement and full development of those distinctive advantages, which the adoption of the Screw holds out. Beyond our ranks, however, a further warning seems yet to be needed before the change from opposition to encouragement shall be permitted to set in. For whenever we see instances of failure in a new Principle laboriously sought out, and enlarged on, and instances of success as anxiously dis-

Signs of unreasonable opposition.

paraged and kept out of sight—Whenever we see the necessary conditions for the success of a Principle violated, and the necessary failure resulting from that violation, quoted as a charge against the Principle itself—Then be sure that we see, not the operations of reasonable opposition, so much as the results of unreasonable hostility; and it will be equally strange and fortunate if such a case do not, sooner or later, insure the reward of trouble. Let us see for a probable instance of these effects, which it may be not uninteresting to watch.

Charges made
by the Penin-
sular and Ori-
ental Company
against Screw
Propulsion.

In a periodical Report to the Shareholders of the Peninsular and Oriental, published by the Directors of that Company about a twelvemonth since, there was seen a statement that they had been invited by the Board of Admiralty to tender for a line of Mail communication between Singapore and the Australian Colonies, to be carried out by vessels of Auxiliary Steam-power with the Screw; but that they had declined the invitation to tender upon these terms, 'being convinced that such means of 'executing the Service must be deficient in point of punctuality 'of arrival, and consequently of little or no value to the important 'Colonies of Australia.'

This was, no doubt, a very severe charge to be brought by such an Authority against that which proposed to be a 'Principle 'of improvement' in steam navigation; and, if true, it must effectually exclude the said Principle, from all fitness for employment in one of the most important services for which steam navigation is available. But from whatever practical source the Directors of the Peninsular and Oriental may have derived their 'convictions;' it is quite clear that those 'convictions' *could not* have been shared in by the Admiralty when making such an invitation. And it is equally clear that they did not share in them, after their invitation had thus been made and declined; because in their turn, the Admiralty declined an offer from the Peninsular and Oriental to carry out the proposed Service with Paddle-vessels; and then they turned in another direction to

seek for the means of introducing the economy of the Screw-vessel, into the Mail Contract Service; and this time with better success.

The Brazil line of Mail communication is the only one of the original sailing lines, to which Steam navigation has not been as yet extended; and this line it was determined by their Lordships to surrender into private hands, and make it the means of introducing the Screw Auxiliary into this branch of the Public Service. Accordingly, after the negotiations with the Peninsular and Oriental had failed, in the month of November, 1848, tenders were invited for a Brazil Mail Contract to be carried out with Screw Auxiliaries. And in February, 1849, the contract to perform this Service, with these means, was awarded to another great Company,—the Royal Mail Company; which thereupon undertook, and which is now engaged, to work out a Mail Service to the Brazils upon a public grant of 2*s.* 9*d.* per mile, as a remunerative allowance when employing Auxiliary Screw vessels; whereas it requires 12*s.* 6*d.* per mile as a remunerative allowance, to enable this same Company to work out a Mail Service to the West Indies, when employing full-powered Paddle-vessels. It being presumed that an equal ‘mean rate’ upon both these lines of Service, and equal ‘punctuality of arrival’ is sufficiently guaranteed for, by the terms of both Contracts, as a matter of course.

Now, all this seems significant enough to merit these few passing words of explanation.

In making the original invitation to the Peninsular and Oriental Company, towards the close of 1848, the Admiralty had based their ‘convictions’ of the value and economy of introducing the Auxiliary Screw vessel into Mail employ, upon the steady and uninterrupted success of the Auxiliary vessels of Mr. Laming; the performances of which I have quoted in the last Chapter; and the progress of which their Lordships had closely watched for a period of more than two years. But side

Screw Propulsion adopted for the Brazil Mail Contract by the Royal Mail Company.

The Peninsular and Oriental prefer the failure of the Screw at Liverpool against the success of the Screw in London;

by side with the well-ordered experience upon which the Admiralty thus based their 'convictions;' there occurred elsewhere an experience the very reverse, on the results of which the Directors of the Peninsular and Oriental preferred to base theirs. Fanciful Screws and fanciful engines, in disregard of experience acquired elsewhere;—a misapprehension of the merits of the Principle itself;—and misarrangement, and mismanagement, in working those merits out—All these, combined with an over amount of local self-confidence, had contributed to make the Port of Liverpool as remarkable for the failure of the Screw, as the Port of London is remarkable for its success; and an invitation which the Admiralty were induced to make upon the successes of the Thames, was rejected by the Directors of the Peninsular and Oriental in consequence of the failures of the Mersey. Whether wisely or otherwise, time will tell; but the rejection itself held good, solely, because there was no other Company of sufficient experience and energy to compete in the direction prescribed, for the offered Service which they thus declined.

which may be explained by the difference of mileage required under Screw Propulsion as compared with Paddle Propulsion.

Such, however, was not the case with respect to the Brazil line of Mail Service; in this instance the Screw Steam Shipping Company which owned the Auxiliary vessels, whose performances I have quoted, were close and anxious competitors with the Royal Mail Company for the Contract. They offered the experience of two years and a half of undeviating success as a guarantee for the perfect efficiency of the Screw Auxiliary to execute the Service. They undertook, on the strength of that experience, to ensure the same 'mean rate' at 3*s.* 4*d.* per mile, which the Royal Mail Company on their main line could only undertake to perform for 12*s.* 6*d.* per mile. And these offers were only not accepted, and have only not been worked out, because the Royal Mail Company itself undertook to perform the same Service at 2*s.* 9*d.* per mile. And the Contract thus awarded them on these terms, is held by them at this time; although I am not aware, as I write, of the extent of pre-

paration made by them for fulfilling an engagement which they cannot but be deeply interested in doing, since it must enable them to acquire experience in the management of that, which, if it be indeed a ' Principle of Improvement ' in Steam Navigation, must of course contribute materially to the permanence of their Company. But, as I have said before, all these circumstances do appear to be significant;—they indicate a determination on the part of their Lordships to introduce the Principle of Screw propulsion as the future means to work out all competent lines of Mail Communication; and in such determination it is easy to see that their Lordships have every inducement to proceed. There is the inducement of a mileage at least two-thirds less than that now required; there is the inducement of an increasing confidence and experience in the perfect efficiency of the Screw to effect such Service. And there is the inducement supplied by the following considerations, of a wider and more permanent nature still.

It is an axiom in Steam-Navigation that the Principle of Paddle-propulsion is a Principle incapable of self-support. Paddle-steamers in short voyages or coasting trips, in which large stores of fuel are not required, are found able to reserve a sufficient space for cargo, the freight of which may realize a profitable return for expenses. But ocean voyages with Paddle-vessels are necessarily deprived of this first requisite of profitable remuneration; and that under conditions which I have before alluded to, as constituting an inherent defect as regards economy in the Principle itself. In the first Part of this book I stated, in somewhat axiomatic form, that as a general rule, the Paddle vessel " will sail the fastest without her Paddles, and paddle the fastest without her Sails;" (except when employed as a mere steadiment;) and in support of this statement I adverted to the several Special Reports of the " Terrible," in order to prove, by graduated results, that the employment of even the fullest sail-power, in assistance of the fullest steam-

Paddle-propulsion incapable of self-support, and its consequent expense.

power, however it might improve economy, would only decrease speed. And now I may further confirm this proof by the universal practice, and acknowledged necessity, that, in order to ensure a steady "mean rate" of speed from the Paddle-steamer on the ocean, it is requisite to provide a sufficient amount of steam-power to enable her to perform every part of her voyage, whether head to wind against adverse gales; or whether running before fair ones; under steam alone. Thus, the unavoidable results of an inherent condition, impose the requirement of very large engines, to be kept constantly at work. And this requirement can alone be met by providing very large ships; capable of carrying the very large cargoes of coal, required for the constant consumption, of gigantic machinery. Then, the very large cost, and very large current expenses, involved by these requirements, can alone be borne by very large Companies. And very large Companies, even, can alone bear these large expenses, when supported by very large payments out of the Public purse. Moreover, an expediting of the preliminaries of commerce; and not an expediting of the great bulk of general objects of which commerce itself consists, is, under these circumstances, all which the Paddle-steamer can effect upon the Ocean; and that under the same inexorable conditions as before; viz., because the requisite cargo of coals is too large, to admit of anything but a minimum cargo of goods. Orders are rapidly exchanged; and the state of markets made known; but the practical reply to those orders, made by supplying the markets themselves with the general goods required, remains, in all but a limited extent, in the same state as before the Paddle system. Sailing-ships must still carry general cargoes;—Steam will not pay.

Screw-propulsion capable of self-support, and its consequent economy.

But under the same axiomatic form I also stated in my first Part the very reverse condition inherent in the principle of Screw-propulsion; viz., that the Screw-vessel 'sails the 'fastest with the aid of the Screw, and screws the fastest with 'the aid of her Sails;' and it is this inherent distinction between

the two principles, which gives rise to the fact that what the Paddle cannot do, the Screw can.—It is this reverse condition, which enables the Screw-vessel to convey every bale of goods from our wharves to its destination at Steam-speed ; and at a profitable freight. She is able to do so because, in her case, it is *not* requisite to provide ‘a sufficient amount of Steam-power to enable her to perform every part of her voyage, ‘whether head to wind against adverse gales ; or whether running ‘before fair ones ; under Steam alone.’ Sails can, and do co-operate, and combine at all times ; so that she is not required to go ‘head to wind’ at all ; and the power of canvass does not, as in the Paddle-vessel, go to decrease speed, but it goes to increase it ; and a limited amount of Steam-power, thus combined with the Sails ; unite to produce the same ‘mean rate’ with the Screw, which with the Paddle, must be produced by Steam alone. And thus large engines are not requisite ; and thus there are minimum cargoes of coal ; and maximum cargoes of goods ; instead of maximum cargoes of coal ; and minimum cargoes of goods. And every cost and expense is very much diminished ; and every profit is very much increased ; and money can be fairly earned under the one system, under circumstances, which would only involve loss under the other. Thus the whole case of disabilities and dependence, is changed into a case of facilities and self-support. And letters can be carried just as quickly as before ; and goods can be carried a great deal quicker and cheaper than ever. And instead of the Public purse being dipped into for large grants as at present ; it has to be dipped into for small grants only—For three and four-pences ; and two and nine-pences ; where now twelve and six-pences are required. And thus it cannot but be that any Admiralty, and any Government, to whom these things are now known ; should be actuated by the strongest inducements, to introduce wherever they can, a self-supporting and more effective system ; rather than a dependent and less efficient one. And, therefore, it can-

Government is therefore more interested in perfecting the Screw than it can be in maintaining the Paddle.

not but be that the present Admiralty, and the present Government, are more directly interested in perfecting the Screw, than they possibly can be in maintaining the Paddle. And not to see these things which are passing under our eyes; and not to heed them; and to play at cross purposes with the Admiralty by going all the way to Liverpool to look for failures, when their Lordships are referring to London success; does appear to argue at least as much want of consideration and foresight in the management of affairs beyond the sphere of the Navy as has ever been charged as taking place within it. It also may yet be found to realize results, which will afford very grave occupation over their own circumstances; to those who are always so eager to cast blame upon ours.

The charges of "want of punctuality" advanced against the Screw, shown to be perfectly gratuitous.

And now let me show that there was in reality no more foundation for the gratuitous charge against the Screw Auxiliary for 'want of punctuality of arrival;' than there was of consistency in quoting the ill-ordered experience of Liverpool as any reply against the results of the well-ordered experience of London.

It will be allowed on all hands that the highest degree of 'punctuality' which has ever been ensured by mail communication across the Ocean, is that which has been exhibited by the admirable line of Steamers of Mr. Cunard; and the evidence furnished by the performances of two of these Ships, quoted in the last Chapter, and which, up to a recent period, were the two fastest Ocean Steamers known; will give the best idea of how far punctuality can indeed be boasted of as an attainable object; at least up to the period when the charge against the Screw was made by the Directors of the Peninsular and Oriental. For instance:—

In eleven voyages out from Liverpool to Halifax, the time of the "Hibernia" varied from 11d. 7h. 30m., to 18d. 13h. 40m.; showing an extreme variation of 7d. 6h. 10m., with all intermediate variations between.

In eleven voyages home from Halifax to Liverpool, the time of the "Hibernia" varied from 9d. 1h. 10m., to 11d. 15h. 10m.; showing an extreme variation of 2d. 14h., with all intermediate variations between.

In eleven voyages out from Liverpool to Halifax, the time of the "Cambria" varied from 10d. 22h. 15m., to 16d. 4h. 10m.; showing an extreme variation of 5d. 6h. 55m., with all intermediate variations between.

In eleven voyages home from Halifax to Liverpool, the time of the "Cambria" varied from 8d. 23h. 55m., to 13d. 2h. 35m., showing an extreme variation of 4d. 2h. 40m., with all intermediate variations between.

And in the forty-four voyages thus performed by two of the fastest ships, of the fastest line of Paddle-steamers, we find an extreme variation of 9d. 14h. 59m., in the time of performing a distance of 2550 miles: this variation amounting to an extreme difference of 106 per cent. in time; with forty-two intermediate differences between.

I refer to these circumstances, only, for the purpose of showing, that what with variations between one ship and another; what with variations between one season and another; what with variations between voyages out and voyages home; between voyages performed in the same ship in the same season; and voyages performed in the same ship in different seasons; performed in different ships in different seasons; and in different ships in the same season, &c., &c., &c.; real 'punctuality of arrival' appears to be an unattainable object at present, by means of any such powers as are placed at our disposal. And whatever other cause the Directors of the Peninsular and Oriental may have had for declining to tender for the employment of the Screw; their charge against it of 'want of punctuality of arrival' is as little founded upon any sound experience which could have come within their knowledge, as was the inference, that this desirable quality can be attained with the

Paddle; which their offer to employ it for the Service required, was necessarily intended to convey.

Punctuality, where soundly provided for, equally as attainable with the Screw as with the Paddle.

The truth is, that the claim of the Screw to maintain a mail communication with regularity, rests upon the very same basis as the claim of the Paddle; viz., upon its ability to realize, throughout all the natural variations of the year, climate, and other circumstances, a high average speed or 'mean rate;' and proof of the power to afford this 'mean rate,' is the only proof, which is, or can be exacted, as a guarantee for the performance of Mail Service on the Ocean, from the one as well as the other. This proof has been openly and amply afforded to all who would see it, by a now four years' uninterrupted work of the Auxiliary vessels I have quoted in the last Chapter; and this proof of competency appears to be the only one upon which the terms of a Mail Contract can be based, until such time as the several contingencies of winds, waves, weather, and accidents, are placed more under human control than now they are.

The reasons for this digression from the more general subject.

I have allowed myself to be led into this digressive Chapter for these several reasons:

First;—So much of embarrassment and mistrust with respect to the whole question of Screw-propulsion in the Navy, has arisen from circumstances which have occurred within its own sphere, that I have desired to prevent the aggravation of these embarrassments by disproving groundless condemnation and misrepresentations of the Principle, from without.

Next,—While pointing out for rectification, such oversights as I conceive to have occurred to ourselves; I have desired to show to others that there are circumstances attending this introduction of a great and extensive change, which may give them full cause for caution against oversights—quite as extensive as any with which we have had to deal.

Next,—I have wished to point out that between the two mechanical Principles of the Screw and Paddle-wheel, there do

exist inherent and essential distinctions, which produce equally broad effects, whether they be employed respectively for Naval or for Mercantile purposes; and I have wished to point out what the practical working of these distinctions is. Not for the purpose of disparaging the Paddle, but for the purpose of showing that the advantages of the Screw can only be realized, *when its distinctive merits are carefully and soundly studied and provided for.*

Next,—I have ventured to hope that I might draw attention to the mode in which this subject appears so directly to affect that Civil branch of Service which is under the administration of the Admiralty; with the view to its being called upon to share in those demands for reduction, which now fall with such exclusive weight upon the more Military branch. Our present Mail Service absorbs nearly 800,000*l.* of the annual revenue of the country; and it may be found that both present and prospective economy can be extensively effected, by gradually but firmly introducing into it, whenever, and wherever, it can be prudently and properly done;—the rejected Principle of the Peninsular and Oriental. A Principle which, the ‘Directors’ of the whole community—the Government,—merit so much commendation for having secured in the instance of the Brazil Mail, for the benefit of this great “Company” over which they preside. Because it is a Principle which is capable of reducing public expenditure at the same time that it improves general commerce.—Because it takes less out of the public purse, and puts more into private ones; while Paddle-Propulsion draws very largely upon both.—For instead of carrying goods, the Paddle is compelled to carry coals only; and then, it calls upon all of us to pay for the expense of burning them.

Let me then support the general purport of this Chapter by adding the few following facts. The Company to whom belong the Auxiliary vessels, already so often quoted, had strong reasons to expect that the Contract for the Mail to the Brazils

The foregoing views of the peculiar competency of the Screw to be employed in

Mail Contracts
further sup-
ported.

might have been awarded to them; and they had prospectively ordered three Ships to be built for the purpose of executing it. These Ships are of 530 tons, with Engines of 80 Horse-power each; and on the completion of the two first, they were taken before the 'measured mile' in Long Reach, and their speed very rigidly tested, and ascertained to be; for the "Bosphorus" 9·68 knots per hour; and for the "Hellespont" 9·65 knots per hour. But in consequence of the Brazil Contract having been awarded to the Royal Mail Company instead of to them, these two Ships have been placed on a line of communication between Liverpool, Constantinople, and London; and I have now before me the results of the first voyages of each of them while thus employed; from which it appears that they have together run over a distance of 12,766 miles at a 'mean rate' of 7·91 knots per hour, out and home. Now it will be recollected that the Ocean speed of the Royal Mail Company's Steamers to and from the West Indies, is 7·65 knots per hour, as a 'mean rate;' and it was this 'rate' which the Screw-shipping Company engaged, in their tender, to perform on the Brazil line of Mail Service, if awarded to them. So that we have clear evidence of the perfect competency both of the Principle, and of the Ships themselves, to execute the Mail Service tendered for; because we find them realizing a 'mean rate' one quarter of a knot per hour, higher than that which they undertook to ensure. We also find that this 'mean rate' has been realized at a period of the year, viz., from the middle of September to the beginning of December, which is not favourable to a high speed; and that it has been realized upon a line of Service far more unfavourable than that of Mail employ to the Brazils. And in further proof of the equal competency in the Screw as well as Paddle for the performance of Mail Service, it may thus appear worthy of notice, that *Auxiliary* Screw-vessels of only 530 tons, and only 80 Horse-power, have thus shown themselves able to perform a higher Service than that which is

now performed on the West India line by *Full-powered* Paddle-ships of 1300 tons, and 400 Horse-power. So much for the competency of the Screw ; now for its Self-Support.

These vessels of 530 tons with 80 Horse-power, have taken out and home cargoes of the average amount of 360 tons ; while the West India vessels of 1300 tons and 400 Horse-power can only carry an average cargo of 70 tons. Moreover, these Auxiliary Screw-vessels are now engaged in the same trade as certain vessels belonging to the Peninsular and Oriental, which vary in size from about 900 tons, with 280 Horse-power, to about 1200 tons with 400 Horse-power, and which do not, I believe, carry larger average cargoes ; nor make their average voyages in less time, than the 16d. 20h. as yet occupied by the Auxiliaries between Constantinople and back. But even if I am in error to some small extent as to the actual amount of average cargo carried ; and the actual period of the average voyage made, by the vessels of the Peninsular and Oriental ; I am not in error when I state that the practical difference between Paddle-propulsion, and Screw-propulsion—that is to say ; between large ships carrying large cargoes of coal, and small cargoes of goods ;—and small ships carrying small cargoes of coal, and large cargoes of goods ; amounts to this ;—viz., That the Auxiliaries are able to make a profitable return upon freights which are 22 per cent. lower than those demanded by the Full-powered Steamer ; both being employed on the same line of trade—a fact which is perfectly well known to the Directors of the Peninsular and Oriental ; and, therefore, it is just possible that the charge of ‘incompetency’ urged by them against the principle of Screw-propulsion, may not have originated so entirely from a disinterested regard for the convenience of our Australian colonies.

CHAPTER IV.

ON THE FORMS OF THE SCREW-SHIPS OF THE NAVY.

PART I.

THE CAUSE OF THE DEFECTIVE FORM OF OUR SCREW-SHIPS
TRACED OUT.

THE subject which supplies a title to this chapter is one which is too important in itself to leave unnoticed. And so much both of encouragement and warning may be derived from a dispassionate examination of it, that it would not be consistent to overlook it in a work like this, which purposes to treat of the whole history of the Screw as connected with the Navy. Much however of the instruction afforded by it is of a nature sufficiently grave to call for both carefulness and precision in setting it forth; and therefore in reviewing the whole subject of the 'forms of our Screw-ships,' it will be my endeavour to combine impartiality and truthfulness with as much of conciseness as the many important features presented by it will permit.

A fine form of after-body given to the original successful Screw-ships.

To begin then with the beginning. To Mr. Francis Pettit Smith are we indebted for the "Archimedes;"—to the "Archimedes" for the "Rattler;"—and to the "Rattler" for our present Screw Fleet. Again, Mr. Smith determined the form of after-body to be given to the "Archimedes;"—the "Archimedes" determined the form of after-body to be given to the "Rattler;"—but—there the link was broken; and as this early breach in a hitherto successful chain of experience was necessarily made for a specific purpose, and was the occasion of extensive results, it will, I believe, be found important and valuable to

trace both the cause and the consequence, and to examine the nature and merits of them both.

The trials of the "Rattler" in the Thames in 1844, 1845, were made under the inspection of the highest practical skill and talent in the kingdom, and had fully established the equal propelling powers of the Screw with the Paddle-wheel in smooth water. But it was requisite to confirm this result by more extended and practical work upon the Ocean; and therefore when the trials were ended, the ship was made over to be prepared for commission, and completed as one of the armed force of the Navy.

And here it seems first to have occurred with the "Rattler," to be regarded as no more than any other ordinary 'Steamer;' and although she presented throughout her length, the first instance of an unencumbered broadside, capable of being made to mount whatever guns her available displacement would admit of; still, to every other ship designated as a 'Steamer,' it had been usual to supply from our Arsenal what was technically known as a 'Steam armament;' that is to say, a battery consisting chiefly of heavy guns to be mounted on the clear space of deck at each extremity of the ship; and the only important distinction recognised between the "Rattler" and every other 'Steamer' hitherto an applicant for artillery equipment, appears to have been, that for this mode of receiving her artillery she presented herself very defectively prepared. Her foremost extremity was indeed capable of being supplied with the usual heavy pivot-gun; but her aftermost extremity, which had been constructed with reference to the nature of her propeller, was found incapable of being similarly mounted; and this inability seems to have been regarded as a serious defect in her armed capabilities; and to have occasioned a requirement, that any future ships to be built upon the principles of the "Rattler" might have their aftermost, as well as their foremost extremities, prepared for receiving a 'Steamer's' appointment of guns.

The Screw-ship to be prepared for receiving the same mode of armament as the Paddle-steamer.

This preparation inconsistent with the original and successful fine form.

The inconsiderate remark that the Naval Steamer is unable to compete in speed with the private one, has always met its most appropriate reply by pointing to this heavy battery in the very extremities, as a condition which controls most unfavourably the design of the Naval Constructor. But if he had hitherto been debarred from fine lines of 'run' and 'entrance,' in order to provide support for the heavy guns with which the extremities of Paddle-steamers have to be loaded; how much more must he 'fill out' the after-body of the Screw-ship, in order that it might support the undiminished burthen of this heavy battery, to be doubled perhaps by the weights of the Propeller! In such a case it was clear that the introduction of the Screw, instead of relieving the Constructor of his difficulties, must greatly aggravate them. Instead of facilitating the improvement of his forms, by enabling him to improve their extremities, it must force him to make them still worse. For a fulness of after-body, greater than any which had hitherto been necessary even in the Paddle-steamer, would be the only alternative left for him to adopt in the Screw-ship, if the requisition to have their sterns prepared to accommodate the gun-slide of the Paddle-steamer should indeed be carried into effect. And carried into effect it was. No intention to change a course of long standing would seem to have been noticed; doubtless because no change in the *Instrument* of Steam-power could be seen as a sufficient reason for changing the appointment of the guns. Whether a ship were propelled by one Screw or two Paddles, was there not a Steam-engine to do the work in both? Were not both therefore evidently 'Steamers?' And never since the Steamers of the Navy had first applied to be furnished with artillery, had our Arsenals ever been expected to provide for them any other than 'Steam armaments' alone.

That the battery which had been reduced to incompleteness by the exigences of the Paddle-wheel, could be restored to full power by the adoption of the Screw—That the exposure of the

engines in the one case could be exchanged for complete protection in the other—That a detached and partial armament only capable of being brought into limited and cautious use, could be replaced by an unbroken and powerful broadside, capable of meeting every circumstance of warfare—These most important and essential distinctions between the two Principles, which had constituted the special objects for the sake of which the introduction of the Screw had been urged and sanctioned ;—these distinctions could never have fallen under knowledge or notice, where it was required that the Screw-ship should be prepared for that exceptional and incomplete equipment of the Paddle-steamer, which it was expressly intended she should supersede. And because these important distinctions were not appreciated, where nevertheless the requisite provision must be made for working them out, therefore they came to be disregarded altogether ; and because they were disregarded, therefore they came to be violated ; and because they were violated, therefore in due time all which followed appears to have flowed in as a matter of course.

In 1845, circumstances required a large increase to be made to the strength of the Steam-Navy. At that time the “ Rattler” had shown that the Screw could realise at sea the promise held out by its performance in the river, and after long deliberation it was determined that the required increase should be made chiefly in ships so propelled ; and thus that a foundation should be laid for securing in our future Steam-Fleet the superior man-of-war advantages which the Screw was seen to hold out. These advantages, so far as regarded the restoration of an effective broadside, were seen to require the construction of an entirely novel class of marine machinery capable of being worked in a position of security under water. And the success of a primary object was thus seen to depend on the completion of a very difficult and doubtful task. Because the construction of powerful engines of a character so entirely

The consequences of thus preparing the Screw-Fleet of 1845.

novel, was seen to require a total change in all the ordinary labours of the designing - room, drawing - office, model-loft, foundry, and workshop of whatsoever establishment might be induced to undertake the job. Such changes it was also seen must greatly enhance the risks of failure in any individual case, and therefore it was further determined not to place reliance on any individual attempt at all, but to ensure success by enlisting the efforts of every Engineer of eminence in the kingdom to secure it.

Accordingly twenty-three pair of Screw-engines, illustrating the respective views of their several Projectors, were decided on, contracted for, and commenced, after much anxious deliberation; and twenty-three ships in which to try the engines when completed, were necessarily at the same time appropriated, converted, or ordered to be built. And as it was with the engines, so it was with the ships; the enterprise and talents of private parties, as well as public servants, were to be enlisted to complete them. And as it was with the Engineer, so it was with the Constructor; each might put forth the effort of his own individual ability and talent, but each must comply with certain conditions in his work. But here it would seem that co-operation could not have been directed with a necessary regard to the fulfilment of one common object. For while it was required that the engines should be designed so as to give effect to the complete broadside, which the Screw had been adopted to restore; the forms of the ships were controlled by the requirement to prepare them for that incomplete 'Paddle armament' which the Screw had been meant to supersede. And the seeds of this want of unity of purpose grew up to produce their fruit.

These consequences illustrated by the experiments on the "Dwarf."

As early as March, 1846, Mr. Lloyd, the then Chief Engineer of Woolwich factory, became convinced that the afterbodies of the Screw-ships then building were at variance with certain acknowledged principles of form, and that they must prove very detrimental to the speed of the ships themselves, by

whatever means or machinery it might be intended to propel them. Permission was, therefore, solicited and obtained by him for instituting a series of experiments, with the view to ascertain the correctness or otherwise of his views.

The "Dwarf" was the vessel selected, and the experiments made upon her confirmed in full extent the convictions of Mr. Lloyd. The "Dwarf" after some delay was taken into dock, and the form of her after-body was 'filled out,' so as to represent proportionally the form of after-body of the ships then building. Care was taken that the 'filling' should be brought to coincide, as near as possible, with the general lines of the vessel, and that it should present no abruptness or obstruction, which might aggravate the effect of the form itself. The 'filling' was made by means of three separate and independent layers, capable of being removed, the one from over the other, without disturbing those beneath; so that the effect of the alteration in form, whatever it might prove to be, should be confirmed by three several gradations of proof.

The first and second only of these graduated experiments were made. In that which took place on the 3rd of October, 1846, the "Dwarf's" speed was estimated to be 3.25 knots per hour, the engines making 24 revolutions per minute; this was with the greatest amount of fulness of after-body. In that which took place on the 23rd of the same month, the "Dwarf's" speed was found by Massy's log to be 5.75 knots per hour, the engines making 26.5 revolutions per minute; this was with the next less amount of fulness of after-body. And these two trials were considered to be conclusive. Because before the alteration of her form, the "Dwarf's" speed at the 'measured mile' had been ascertained to be 9.11 knots per hour, the engines making 32 revolutions per minute; and so soon as the 'fillings' were taken off, and the vessel had been restored to her original form, the "Dwarf" again returned to her speed of 9 knots.

The result of these experiments, therefore, went to establish three points. First; that the full sterns of the new Screw-ships would prove most detrimental to their speed. Next, that it would greatly reduce the effective power of their engines. And lastly; that it would almost destroy their power of steerage when under steam; for the "Dwarf" had been so affected in this respect by the alteration of her form, that it would have been quite unsafe to have taken her among the shipping in the river; although when in her proper form she possessed that superior steerage-power, which is peculiar to the use of the Screw.*

These consequences confirmed by the trials of the "Rifleman" and "Teazer."

The results obtained by the experiments on the "Dwarf" were to be further corroborated, however, before being acted on. Among the smaller Screw-ships building were two pairs, each of which pair were of different dimensions; but each consisted of a wooden and an iron ship precisely alike. The wooden ones were under construction in the Dock-yards; the iron ones were being built in private establishments. And Mr. Miller constructing the "Minx," and Mr. Ditchburn constructing the "Sharpshooter;" both pleaded, and both at length obtained permission, that their respective ships might be exempted from that fulness of the after-body, which was still permitted to remain in the "Teazer" and "Rifleman," their two wooden sisters. And shortly after the experiments on the

* The view taken by Mr. Lloyd upon this occasion was, that the full and abrupt after-bodies then building into the Screw-ships, in order to support the combined weights of stern batteries and propellers, must destroy their speed, by creating a large amount of what is technically known as the 'Negative resistance' of a ship; and that such a form must at the same time vitiate the propulsive effort of the Screw itself upon the water. The reduction of the power of the engines by so great an amount as one-fourth, as in the first trial; and the nearly total privation of the steerage power upon both occasions;—these appear to have been unexpected results, in a degree unaccounted for to this day.

• The "Dauntless," in her unaltered form, has exhibited this same peculiarity of defective steerage; spinning round the entire circle of the compass in ten minutes when her helm was left alone.

“ Dwarf;” the corroborative trials between the full and the fine form, as exemplified in these two pair of vessels, were carried out with careful exactitude, and with the following results.

The speed of the “ Sharpshooter ” was ascertained to be 9·916 knots per hour, and that of the “ Rifleman ” 7·903 knots only; showing a difference in speed of 2·013 knots, or 25 per cent. in favour of the finer form. These were two vessels of 484 tons, with engines of 200 Horse-power each.

The speed of the “ Minx ” was ascertained to be 7·848 knots per hour, and that of the “ Teazer ” 6·315 knots only; showing a difference in speed of 1·533 knots, or 24 per cent. in favour of the finer form. These were two vessels of 301 tons, with engines of 100 Horse-power each.

Now since it has been at times remarked that such differences of speed as these ‘ seem after all to be of no great moment;’ therefore it may prove not unimportant to refer these cases to certain well known laws, by which the real value of such differences of steam-speed can be truly ascertained. By these laws it is shown that it would have required additional machinery to the extent of 195 Horse-power; or practically, that the Engine-power should be doubled in the “ Rifleman,” in order to raise her speed to that of the “ Sharpshooter.” And that it would have required additional machinery to the extent of 95 Horse-power, or practically, that the Engine-power should be doubled in the “ Teazer,” in order to raise her speed to that of the “ Minx.” And if these numbers be respectively multiplied by 62, and the product be considered as Pounds Sterling, we shall then find that 12,090*l.* and 5,890*l.* would be the *cost price* of making these respective additions in machinery. And if to these sums we add 19*l.*, and 9*l.*, respectively, as the *expense per day* for additional fuel required for working such additional machinery; we shall then ascertain the cost price and current expenses of equalizing such differences of speed as took place between these ships. Thus

A practical view of the importance of the above experiments and trials.

a very comprehensible and practical idea may be given of their real value, as distinguished from their apparent importance. And I need scarcely point out, that the same estimate which fixes the cost of such differences of Steam-speed, fixes also the cost of that defective form of construction by which such differences were produced.

PART II.

THE ORIGIN AND THE NATURE OF A 'STEAM ARMAMENT.'

WE have thus traced out the immediate cause for which the successful forms of the "Archimedes" and "Rattler" were departed from; and we have seen by the trials of the "Rifleman," the "Teazer," and the "Dwarf," that in order to prepare the Screw-ship for the mode of arming the Paddle-steamer, it had been found requisite to impose upon her a malformation of the after-body, which destroyed the working power of the Mechanical Instrument itself which the ships were intended to employ. The immediate suspension, and eventual alteration of the Screw-Fleet then built or building, were the obvious and necessary consequences. But before tracing these consequences into further detail, it may be well to examine into the nature and merits of that mode of arming a ship-of-war for the sake of which such grave consequences were thus incurred.

The merits of
"Steam" or
"Paddle arma-
ment" exam-
ined.

First then, as regards the effect of a 'Paddle armament' upon the general character and fabric of the ship herself. It has been found by all who have ever attempted the construction of a Naval Steamer, that the necessity of providing for a battery of guns of the heaviest calibre in the very extremities, imposes conditions of form so unfavourable to speed; that a resort to very high and expensive proportions of machinery is the only means by which it is secured at all. It is also to be believed, that this fulness, and consequent buoyancy of the extremities, materially aggravates that violence of motion in bad weather, which is necessarily induced by such an unfavourable position of the chief weights of armament themselves. So that what with the weight of the Paddles suspended over each side, and

Its effects upon
the Ship her-
self.

what with the weight of heavy guns attached to each extremity ; it is difficult to conceive any description of ship subjected to conditions less conducive to that easy and regular motion, which is just as necessary for the effective use of naval artillery, as it is essential to the durability of the ship herself.

Its effects upon
her supplies of
stores.

Next, with respect to establishing the ordnance equipment of our Steam Force upon some simple and uniform system ; perhaps there may be special advantages presented by ' Paddle armament ' here. On the contrary, the only uniform system which it appears capable of establishing, is one of constant change in almost every important item in the armed equipment of a ship-of-war. Guns of all variety, in length, weight, charge, character, and calibre, have been designed and cast expressly for perfecting this system of arming ' Steamers ; ' and more numerous still have been the plans for mounting, working, pivoting, pointing, compressing, controlling, transporting, and securing them. ' Paddle armament ' has given birth in the Navy to a variety in length of gunslide alone, which is almost as numerous as that of our ' Steamers ' themselves ; for every variation in the breadth of the one has to be met by a corresponding variation in the length of the other. For instance ;—it is ruled as requisite for safety that the muzzle of each gun should project beyond the ship's side, and it is the duty of the gunslide to enable the gun to comply with this requirement ; therefore a radius is struck from the centre of the ship at some point near her extreme end forward ; and another radius is struck from the centre of the ship at some point near her extreme end aft ; and the different lengths of these two radii, determine the different ' lengths of gunslide, ' and different ' distances of pivot, ' for the particular guns, in the particular bows and sterns, of almost every particular ' Steamer ' in the Navy. For not only do these two radii necessarily differ according to the different breadths of different ships, but they as necessarily differ according to the different breadths of the different ex-

tremes of the same ship. So that, in this one item alone, 'Paddle armament' requires, in case of war, that almost every separate battery mounted in the bows and sterns of the several 'steamers,' employed on each foreign station, should be furnished with a distinct provision of spare gunslide.

There is no need to enlarge upon the want of support and co-operation between the two armed extremities of the deck, which characterizes a 'Paddle armament;' because it is clear that between the one chief battery at the extreme end of the ship forward, and the other chief battery at the extreme end of the ship aft, with the bulk of the Paddle-boxes between; there exists the smallest amount of mutual support which a ship's deck can be found to afford.

But with respect to facilities of manœuvring, &c., in action, perhaps there are advantages in a 'Paddle armament' here. It would, I believe, be a bold opinion to maintain that there were; for to furnish the extremities of any ship with the most effective portion of her armament seems necessarily to involve, that when fighting at all, the extremities must be exposed to bear the brunt of it. It is said, indeed, that a ship in action, 'end on,' presents a smaller mark for an enemy to fire at; but this doctrine, as applied to ships capable of being armed with an unbroken broadside, must have been at least as true in the days when our fathers fought, as it ever can be in our own. And it ought, I believe, to meet with as little encouragement now, as it surely would have met with, had it ever been propounded then. For it seems a very bold and a very hazardous position indeed to maintain, that we can now reap honour and advantage by courting exposure to a raking fire; when there are so many living witnesses to prove that such an exposure only entailed discredit and loss upon those who were subjected to it, however reluctantly, in days gone by.

Its effects upon
her mode of
engagement.

But, in short, there is no advantage whatever to be found in that which is conventionally known as a 'steam armament.' On

"Steam arma-
ment" always
a system of ne-
cessity;

the contrary, there is not a feature in it which is free from very serious disabilities and defects. It was forced upon us from necessity; not adopted by choice; and it seems much to be regretted that it should not have been even authoritatively abandoned so soon as that necessity ceased. It is a mode of arming a ship purely exceptional, and should therefore be limited to the exceptional case which produced it. It takes date only from the introduction of the 'Paddle-steamer;'—when the Paddle-wheel itself, with its projecting sponsons on each side of it; and the Fore-rigging before, and the Main-rigging abaft these;—left no available space upon her deck for any effective armament whatever, save in the extremities alone. And because in this position the guns must necessarily be few in number; therefore their calibre was enlarged to try and make up for it. And because the mode of machinery which the Paddle requires is necessarily exposed to shot; therefore the range of the guns was increased, to try in some degree to keep it out of mischief. But when the adoption of the Screw had provided for the re-appropriation of the broadside to its original use; from that moment there existed no more reason for imposing on the Screw-ship the disabilities peculiar to the Paddle-steamer, than there exists a reason for imposing them now, upon every Frigate and Line-of-battle-ship in our Fleet. If the filling of the extremities with a permanent battery of the heaviest guns be indeed the discovery of an improved mode of arming ships-of-war; then it would seem necessary that the bows and sterns of every member of our Fleet should be modified for realizing this improvement alike. But, on the other hand, if 'Steam armament' be indeed no more than a system of necessity; adopted as a remedy for defects; and being in itself fraught with them; then, it would seem to be yet more necessary that its application should be strictly limited to that portion of our Force which has entailed upon us the necessity of adopting it.

And that the inherent defects and perplexities of this system have been fully acknowledged, and anxiously contended with, is proved by every passage of its history from the earliest date of its existence. For the exertions to arm the Paddle-steamer with a continuous, effective, and powerful battery, have been no less constant, or strenuous, or costly, than those which have been made to make her also a complete Sailing-ship. The efforts of years have been strained towards this object; each plan and project before adverted to was expressly intended to effect it. And as attempts at a connected armament amidst the paddle obstructions of the upper-deck were gradually abandoned in despair; so Main-decks were resorted to with renewed energy and hope, of seeing the lost broadside restored. Ship after ship, from the "Gorgon" to the "Terrible," has been built with this express design; and scale after scale each has followed the other in increased size; until, in this latter vessel, the desired object was at length obtained. And when, before and abaft the Paddles of the "Terrible," there appeared the muzzles of two guns, pointing through the Main-deck ports of a ship of 1847 tons, and 225 feet between the perpendiculars; the sight was greeted as a triumph, in which the "Odin," and "Sidon," of somewhat smaller dimensions, have since been admitted to share.

and its great defects always known and contended against.

And the difficulties and defects of the Paddle-system thus anxiously contended with; and to this day unremoved; found each its complete and appropriate remedy in the simple adoption of the Screw. The adoption of this Principle at once offered an unencumbered side capable of being mounted with any force of guns which the displacement of the Ship might allow. It offered the means of immediate relief to the overburthened extremities. Every important weight in hull, engines, and armament, was at once capable of being exchanged from an unfavourable, to a favourable disposition. Thus it offered ease of motion and stability. The steadiment in action

Every defect of "Steam armament" capable of complete removal by adopting a full-armed broadside in the Screw-ship

to be derived from the free employment of Sails. Improvement of form ; and hence increase of speed. A promise of greater durability in the Ship herself ; because presenting less objects of exposure to the effects of sea and weather. The Propeller and its machinery working in common security under water ; and facilitating every mode and manœuvre of warfare. Complete co-operation and support throughout the entire armament. Ability to employ any size or description of gun. The supply of every ordnance-store capable of being furnished upon a uniform plan ; even 'length of gunslides' being determined by the requisite recoil of the guns ; quite irrespective of any varying dimension in the Ship. Thus might the lost broadside be restored in the Screw-ship ; and restored with increased effect. Every advantage opened, by skill or opportunity in time of action, might be seized on, and enhanced, by the possession of a power independent of the Sails, yet capable of combining with them ;—a power under more control than the wind, and better protected than the masts.

The full-armed
broadside of
the Screw-ship
always in-
tended ;

And in the earliest days of expected success, all these points of advantage for Naval purposes were seen ; and were examined into ; and constituted the chief and acknowledged recommendations of the Screw. If its extensive introduction had been decided upon at an earlier date than it was, they might all have been as fully secured then, as they are capable of being fully realized now ; for all subsequent experience has but shown the complete ability of our Screw-ships to realize them,—if only provided for. It seems to have been well and prudent, however, to await at first for a more extended and practical knowledge of the propelling powers of the instrument itself. But so soon as proof of these had been sufficiently given ; and when in 1845 the fitting opportunity was seen to have arrived ; then, the extent to which the Screw was at once accepted for the Navy, bears witness to the intention of those who then introduced it to secure the advantages offered by it both largely and permanently ; and

the decisive measure of ordering a new system of machinery to be called forth purposely and solely to work these advantages out; gives ample proof of the determination which must then have existed, to realize them completely. And how do we find, may I ask, that this determination was supported; and how, may I ask, was its success provided for? Why, under the influence of an injudicious exaction to continue that cumbrous arming of the extremities, which it was expressly desired to do away with; the Ships themselves were built with a bulk of after-body which was a departure alike from known experience and known laws. A too facile sanction appears to have been given to a form of construction, which was thus controlled for the purpose—not of realizing improvement, so much as perpetuating defect.—To a form which, instead of providing for an increase of speed; was found practically to destroy it altogether; and which, in the extensive alterations it has inevitably occasioned, has involved us to this present day, in all the discouragements of Doubt, Disappointment, and Expense.

This is of course a painful retrospect to read, as well as write, and it is made,—not because it is painful,—but notwithstanding that it is so; and solely because it is hoped and intended that it may yet prove useful. In specifying the acknowledged defects attendant upon the only known mode of arming a Paddle-steamer, side by side with the equally obvious advantages held out to us by the Screw, it has been intended to show that there do exist inherent and essential distinctions between the two Principles, which affect the entire details of their armed capabilities. And in thus identifying the immediate cause of the errors which commenced in 1845, it has been intended to show that they cast no shadow of reflexion upon the mature and clear-sighted decision which enlisted the merits of the Screw into the permanent Service of the Navy, but that they were entailed because those essential distinctions were unattended to. It has been intended to show that a want of consistent co-opera-

and the serious
results of not
preparing her
for it.

tion marked and marred the early progress of our Screw-Fleet because there was wanting, a common appreciation of the objects, and intentions aimed at, on the part of all those upon whom it must nevertheless devolve to provide for their being worked out. The employment of the common motive power of Steam in any way whatever, appears to have overclouded all perception as to any distinction which it was at all material, or intended to observe, between the old System and the new. The Screw-ship could only be regarded and provided for, like any other 'Steamer,' and for this similar provision, her stern must be similarly prepared. Thus, an impracticable form was given to her, in order yet further to impose upon her that inappropriate, and wholly exceptional mode of armament, which she was engaged into the Service expressly to supersede. And this double violation of the chief objects of its adoption, the Screw itself was left, as it were, to reprove. Because; its intended Man-of-war advantages were thus overlooked; and because a preparation was made, rather to suppress than to develop them; therefore it refused upon its part also, all co-operation of its propelling powers; and thus it undertook to vindicate its claim to be treated upon its own merits alone. And the lesson thus read to us is now pointed out, solely, that it may not have to be learnt over again.

The "Screw-ship" and the "Paddle-steamer" are again confounded together with respect to their mode of armament.

Long subsequent to the events thus traced out, the difficulties attendant upon working the heavy guns of our Steam-Fleet were again submitted to the investigation of a Committee, with the view, if possible, to mitigate or relieve them. And again the recognition, or intended recognition, of any practical distinction whatever to be observed between the principles of the Screw and Paddle, as regards the facilities respectively afforded by them, for an equipment with complete armament; appears to have been as much overlooked as before. The employment of a Steam-engine, again appears to produce the same effect as before in outweighing all other perceptions; and all descriptions of ship, provided with any descrip-

tion of machinery, are promiscuously mingled together and stamped under one general denomination of 'Steam-vessels;' there to receive one common mode of treatment; and that treatment the old mode of arming the extremities. So that although the intractable difficulties of that System were thus made the subject of special investigation; yet the investigation itself results in an endeavour to extend that System into Ships entirely free from all the disabilities which called those difficulties forth. The clear broadside of the Screw-ship seems again as much overlooked, as if it were still surrendered to all the obstructions connected with a Paddle-wheel; and the facility with which the extremities of the ship can be made to accommodate a battery of heavy guns is alone considered worthy of serious attention. The standard measure of the powers and capabilities of the Screw-ship as a man-of-war, are proposed to be determined according as her breadth of deck at the bow, and at the stern, shall be found capable of receiving some particular length of gun-slide in common with some particular Paddle-steamer. All account of essential differences in the disposition of every important weight of hull and equipment, is as totally unobserved as if it had no existence at all, or as if it could be attended with no practical effect whatever if it did exist. But full-powered Screw-ships and Paddle-steamers are all gathered together under one indiscriminate and promiscuous term of 'Steam-vessel.'—All are denounced as alike incapable of being effectively armed for any offensive warfare whatever; and the assigned cause of this incapacity is stated to be 'the established violence of their motions in bad weather'—Which amounts, in effect, to an indiscriminate charge of incapacity made against a whole Fleet of an entirely new description of ship, when as yet no single one of them with complete equipment, had ever been at sea.

That the Screw was substituted into the Navy, not because Are we yet

clear of the error of regulating the form and dimensions of our Screw-ships by the length of their gun-slides?

it is precisely like the Paddle upon the all-important point of armament; but because upon this all-important point it is precisely its reverse; appears to have been as little appreciated upon this later occasion as it had been in the original instance. And this want of observing essential distinctions would as evidently lead again to precisely the same consequences as before. For it is directly submitted, with a view to economy in gun-slides, that the sterns and bows of all 'Steam-vessels' should *again* be 'filled out' to some uniform breadth, in order to accommodate, as nearly as might be, some uniform length of that item of their artillery furniture. So that as late as the middle of 1847 we have a direct recommendation to revert to the same deformity of construction which was forced upon the Screw-ships in 1845, and which has cost us the continual alteration of them from the discovery of our error in 1846, up to this present time. And the professed object of this proposed repetition of so costly a naval error is urged upon precisely the same plea as before; viz., the necessity of affording relief to the difficulties entailed on artillery services, connected with the appointment and preparation of 'Steam armaments'—A term which means in practice, not the close and effective struggle of ship with ship; but a distant and effete random-fire from bow guns, or stern guns, against complete broadsides—a mode of preparing to bring a British ship of war into action which never could have received the serious attention of any Naval Authority whatever; if the necessities peculiar to the Paddle-steamer had not forced it as an unwelcome episode into our traditions; to distinguish the BROADSIDE practice of Sailing days only, from the extension of the same effective practice into Steaming days also;—through the invention of the Screw.

PART III.

THE RESTORATION OF OUR SCREW-SHIPS TO AN EFFICIENT FORM
VINDICATED.

I TURN gratefully to vindicate the removal of that defective form in our Screw-ships, the immediate cause of which has been thus traced out ; and in deference to the temper of the present day, the justification of these alterations shall be based not so much upon the improved efficiency which they have produced in the ships themselves, as upon the actual value which we are able to assign to them in Pounds Sterling.

The "Rifleman" was the first Screw-ship to have the deformity of her after-body removed ; and so soon as the process was completed, she was taken before the measured mile in Stokes Bay on the 13th of December, 1847, and her speed found to have been improved by the operation to the extent of 1·587 knots. It had been 7·903 knots before ; it was now increased to 9·5 knots per hour. The engines, however, upon this occasion were not working so well as they had done upon the trials previous to the alteration, and for this reason, and because the "Rifleman" subsequently underwent a change in her Steam equipment, which illustrates still further the advantage of having altered her form ; therefore no calculations are here based on the above result, only it is pointed out as having been most satisfactory and conclusive.

The results of restoring the "Rifleman" to an effective form.

The change alluded to was that of removing the engines of 200 Horse Power and substituting engines of 100 Horse Power in their place ; and with these latter the "Rifleman" was again tried before "the mile" on the 20th of May, 1848, and her speed ascertained to be 8·011 knots per hour, that is

to say, a shade better than it had been with engines of double the power prior to her alteration. The deformity of the "Rifleman's" after-body had therefore required the effort of 100 Horse Power in order to drag it through the water at a speed of (say roundly) 8 knots ; for so soon as this deformity had been excised ; and the engines of 200 Horse Power removed too ; then the engines of 100 Horse Power which took their place, were found to drive the relieved "Rifleman" rather faster than before. Thus an engine of 200 Horse Power was placed at disposal ; an engine of 100 Horse Power was found to do the same work ; and whatever may have been the expense incurred by the change of form which produced this effect, we are clearly entitled to set off against it, the difference in value of the larger engine, which that change had thus released. And at the actual contract price of 62*l.* per Horse Power, we at once place the sum of 6200*l.* to the credit side of the alteration. But this is the money value of the *improvement* only, and there remains to be reckoned the amount of savings effected by it besides. I will not estimate these *savings* on all the minor items of engine-room expenditure ; I will take the difference of consumption in fuel alone, between engines of 100 and of 200 Horse Power. I will even allow that the aggregate use of steam throughout each year shall amount to no more than one month and a half of full steaming, and thus that it should take 8 years in order to give one year's full consumption. I will estimate this consumption at the usual rough rate of 10 tons and 20 tons per day for the two engines of 100 Horse Power and 200 Horse Power respectively ; and at the very moderate price of 25*s.* per ton as an average for all stations at home and abroad, we shall find, that the alteration is entitled to be credited in the saving of coals alone, with a further sum in 8 years of 4562*l.* 10*s.* So that in this instance we have realized, (say roundly) 570*l.* per annum, as an actual current saving, so long as the "Rifleman"

shall last, wherewith to repay the expenses of having made an alteration in her form, which itself has saved 6200*l.* worth of machinery from total waste.*

But the "Teazer's" history will furnish an instance which possesses even stronger features still. She too, after having her speed carefully tested, underwent the same process of excision as the "Rifleman;" and when completed, a similar change was also made in her steam equipment. Her engines of 100 Horse-power were taken out, and engines of only 40 Horse-power were substituted in their stead, and with these smaller engines her speed was found to be not only equal, as in the "Rifleman's" case, but it was found to be very superior to what it had been before. On the 8th of June, 1847, engines of 100 Horse-power drove the "Teazer," 'as built,' at a speed of 6.315 knots. On the 6th of October, 1848, engines of only 40 Horse-power drove the "Teazer," 'as altered,' at a speed of 7.685 knots; or with an improvement of 1.37 knots per hour.

The results of restoring the "Teazer" to an effective form.

In this instance then, the new engines were only of two-fifths the power of the old ones, and had they produced no more than an equal speed, it would have been clear that the power of the remaining three-fifths, must have been wasted by that deformity in the after-body of the ship, which alone had been altered. But since the new engines produced not only an equal, but a higher speed than the old ones, therefore it is clear that more than three-fifths of the "Teazer's" original Steam-power must have been thus wasted; and it is found in effect that only 22 Horse-power would now give the same speed to the "Teazer," 'as altered,' which it before required 100 Horse-power to give to the "Teazer" 'as built.' So that the obstructions, which the alteration removed, had been

* I have not taken note of the difference of expenditure, due to the increased speed, produced by the alterations. But in this, and the following cases, I have considered a rough estimate of 'saving of fuel' as sufficient for the purposes intended.

actually wasting seventy-eight hundredths, or nearly four-fifths of the whole power of the "Teazer's" engines, when driving the ship at the above low speed of 6.315 knots. Thus, by the alteration of this ship, an engine of 40 Horse-power could take the place of one of 100 Horse-power, and produce an improvement in speed of 21 per cent.; and it is worthy of remark, that the engine of 100 Horse-power thus released from a ship of 301 tons, was placed in one of 484 tons, which larger ship it drove 1.696 knots, or 27 per cent., faster than it had driven the smaller one before. For this engine of 100 Horse-power, which on the 8th of June, 1847, drove the "Teazer," 'as built,' at the speed of only 6.315 knots; is the very same engine, boilers and all, which, on the 20th of May, 1848, drove the "Rifleman," "as altered," at the speed of 8.011 knots per hour.

In proceeding to assign its money value to the "Teazer's" alteration, I will not take account of the "Teazer's" increased speed with her smaller engines; but I will content myself as before with crediting her change of form with the difference in value of the engines she actually *has* had, before and after it was made. At the actual contract price of 62*l.* per Horse-power, a sum of 3720*l.* will constitute this first item of credit; and by the same computation as before, the saving in coals will furnish a further item of credit in the eight years of 2737*l.* 10*s.* So that in this instance also we have, (say roundly) 340*l.* per annum, as an actual current saving, so long as the "Teazer" shall last, wherewith to repay the expenses of having made an alteration in her form, which itself saved 3720*l.* worth of machinery from total waste.

The results of
a supposed
non-restoration
of our Screw-
ships.

But lest fastidious economists should still feel dissatisfied with such a disposition of public money, we will next proceed to take another view of the question; and instead of showing the saving which has been effected by altering the forms of our Screw-ships; we will present them with an estimate of the waste which

must have been incurred, if we had been guilty of working them as they were. This time I will take a large ship instead of a small one; and in order to prove whether these changes have been based upon real experience, or whether they were dictated, as has been said, by mere caprice, I will select an instance in which the operation as yet is only in progress. In such an instance, therefore, I shall have to *predict* as it were a speed for the ship when altered; but as I shall work with this assumed speed with the same confidence as if it were a real one; the fact and the assumption will in all probability admit in due time of being compared together, by any who may be curious enough to do so.

The "Encounter," the "Rifleman," and the "Sharpshooter," all possess one character of design in common with the "Dauntless," and have all come from the hands of the same Constructor; but as the first of these presents the nearest approach to a sister ship, I shall take the "Encounter's" first performance of 10·27 knots per hour on the 19th of March, 1848, and reduce it to 9·75 knots, which I shall consider to be the true speed of the "Dauntless" after she shall have been altered. Premising this, however, that if indeed the "Dauntless" be found, *after full trial*, to have acquired by her change of form a higher speed than this; then, the real expense and waste of working her as she was built, would proportionately have exceeded the expense and waste of so working her, as it is here estimated.

Illustrated by
the case of the
"Dauntless."

I find then that it will require engines of only 246 Horse-power to produce in the "Dauntless," "as altered," that same speed of 7·336 knots per hour, which, on the 28th of August, 1848, it required engines of 580 Horse-power to produce in the "Dauntless" "as built." Upon this occasion, therefore, the deformity in that ship's after-body, which is now in process of removal, wasted the effort of 334 Horse-power, or nearly six-tenths of the whole power of her engines; and if, by the

non-alteration of the ship, that deformity were still to be retained, then it is clear that it must be debited with the expense of the 334 Horse-power which are required to drag it through the water at the above rate; and at the actual contract price of 52*l.* per Horse-power, we should thus get a first sum of 17,368*l.* entirely wasted by working the "Dauntless" in the form in which she was "built." In the cases of the "Rifleman" and "Teazer," the current saving in small stores effected by improving their forms, was excluded from the estimate, which was made in fuel only; and, therefore, in fuel only, I now estimate the waste of not improving the "Dauntless." And taking the same price and the same basis as before, it will be found that the waste of coals required for maintaining the waste of the 334 Horse-power, would amount in the eight years to 15,056*l.* 5*s.* So that in this instance of a supposed non-alteration, we should have entirely thrown away, (say roundly) the sum of 1880*l.* per annum in actual current waste, so long as the "Dauntless" should last, as the continued loss of not altering a defect in her form, which itself entirely wasted 17,368*l.* worth of machinery.

Further results
of the supposed
non-restoration
of the "Daunt-
less."

Therefore to advocate that the "Dauntless" should not be altered, has been to advocate in the first place, that we should incur the fixed and current waste thus set forth. But the expense would not have stopped there; because to advocate that the "Dauntless" should not be altered, was not only to advocate that this fixed and current waste should be incurred; but it was also to advocate that we should retain in the hull of a very large and most expensive ship; of otherwise unexceptionable promise; a single, well-known point of faulty form, which she received in common with a whole fleet of others, for one common object, and which was just as easy of removal in her case, as it had been in that of all the rest. But the effect of this faulty point of form had been ascertained to be such; that the whole effort of very powerful machinery was unable to accomplish for the ship a

speed of more than seven and one-third knots, so long as it was retained. That is to say, it had been ascertained that this single point of faulty form had reduced this ship to a speed which would practically have rendered her unfit either—to ‘overtake,’ or—to ‘run away;’—unfit to afford protection to others, even if able successfully to defend herself. And therefore to advocate the retention in the “Dauntless” of a speed at once so useless and so costly; by advocating the non-alteration of that form which alone produced it; was in effect to advocate and ensure, step by step, the eventual condemnation of the most promising Screw-Frigate we yet possess, as being totally disqualified for the services of a Ship-of-War.

I do not presume to inquire into the sufficient causes which may have occasioned any doubt or delay, in restoring this ship to an effective form. But I may be permitted to observe that her case presented no exception whatever from that of others; and that from the moment that the trials of the “Dwarf” in October, 1846, had established the faulty form in which all the Screw-ships were then building, (with exception, as before noticed, of “Sharpshooter” and “Minx,”) from that time it was known that the “Dauntless” furnished as complete an exposition of the error as any of the rest. It was of great advantage that she should have been taken to receive her engines while yet in the form in which she was ‘built;’ but so soon as she had received them, and so soon as by their means it was ascertained by actual trial before ‘the mile,’ that her malformation was controlling her speed to the above low rate of seven and one-third knots; then every calculation, and deduction which has here been made, could have been openly shown at once; and supposing that it had been so, it must have presented precisely the same features as it possesses now. I may also be permitted to express regret that any doubt or delay in the restoration of this ship, should have had the effect of extending doubt and delay also to the solution of the most weighty problem which

The case of the “Dauntless” never presented any exception to that of other Screw-ships.

But circumstances have rendered her effective restoration specially important.

the Screw yet presents to us to decide. Because in the course of events the "Dauntless" appears now to be the only ship which promises to determine successfully the important purpose of her design; namely, whether full powers of sail; and a full armament of guns; can indeed be made to combine with full Steam-powers, in one and the same frigate; so as to unite improved efficiency and economy, in all the services of peace and war. Assuming that the equipment of our only other Screw-Frigate, the "Termagant," is of course as complete as the ship herself admits; still, as a Frigate of 1556 tons with but 24 guns, and several ports unoccupied; she cannot be taken at present as solving successfully, the question of a full armament of guns. Neither does the present disposition of her masts permit her at present to solve successfully the question of a frigate's full proportion of sail-power;—because in this respect she is practically at present, no more than a large brig; so that unless the "Termagant" shall hereafter be found capable of material improvement; her man-of-war equipment is at present of such a nature as would seem to throw upon the "Dauntless" alone, the task of proving whether we can or cannot realise the intended combined and triplicate powers, of a complete Screw-Frigate.

But to return to the more general subject from which I have thus digressed.

The restoration of the whole Screw-Fleet built in 1845 has been precisely the same in nature and in results in each ship.

Because;—the speeds of the "Rifleman" and "Teazer" were very critically tested both before and after their change of form, and that for the express purpose of measuring the effect it would produce upon them; therefore, the amount of improvement realised is capable in their cases of being satisfactorily valued at a distinct money price. But it is to be observed that whatever in this respect is true of these two ships; is equally true in their several degrees of every other member of the Screw-fleet built in 1845, always saving the two exceptions of the "Sharpshooter" and "Minx." It is equally true in their several degrees of the "Arrogant," the

"Termagant," the "Conflict," the "Desperate," the "Niger," the "Encounter," the "Simoom," the "Vulcan," the "Greenock," the "Megæra." Upon all these there was imposed the one common condition, that unlike the "Rattler" they should be prepared to carry a 'Steam armament' in their sterns as well as their bows; and in all these, this condition had required of their several Constructors a common malformation of the after-body. Some possessed this malformation to a greater degree than those two whose cases I have been enabled more particularly to specify, and some possessed it less. According to that degree, so must have been the extent to which the power of their engines was in every case wasted; and so must have been the extent to which that wasted power was in every case saved. And we are alone unable to state what that actual extent of saving in every case really was; because the greater number of them were altered before their speed was tried. But one common character of alteration, however, has been found necessary in every case; in every case the alteration of the stern has alone been necessary; and in every case this necessary alteration has been attended with one common and most satisfactory result of marked improvement. The extent of that alteration, however, has not been in every case alike. Some were completed before they were altered; some were altered before they were complete. Some have been effectively altered without the necessity for their being lengthened; others have had to be considerably lengthened in order to be effectively altered at all. The "Dauntless" is of this latter class; she is the last of the thirteen to have her defective form removed; and when in her case the improvement is effected, she too will enable us with the "Rifleman" and "Teazer" to calculate with exactitude the value of the increased speed produced. And supposing that this increased speed should not exceed the money estimate I have given for it; even then, I shall be held perhaps to have vindicated successfully the alterations of our Screw-Fleet, which

will then be complete. And the most fastidious economist,—he who is readiest to declaim against the constant operations which our ships are undergoing; must then admit that no public money was ever more properly or more profitably expended, than that which has gone to restore an efficient form to the Screw-Fleet of 1845.

The above calculations exhibit the very expensive difference between a fine form of after-body and a full one,

But it has not been for the sole purpose of justifying these alterations, that the calculations which show their necessity and importance have been here put forth in detail. There has been the inducement of a far higher, and even a more extensive object still. In thus showing the positive value of an improved form, as determined from actual experiments instituted for this very object; it has been my purpose and my wish to fix attention the more strongly to the positive expenses and waste of a defective one—to the serious results which are certain in one way or other to ensue, from any tampering with the forms, and with the proportions of the Ships of our Navy, for purposes however plausible in themselves. It has been my purpose and my wish to fix attention to the necessity for securing our Constructors, as much as possible, in the performance of their very difficult and delicate task of design—against inconsiderate demands, or blind conditions. And this, it was felt, could not be done with the full effect which its importance has seemed to me to merit; until the cause, for which a defective form in our Screw-ships had been required, had first been dispassionately examined into, and traced out. This has now been done. In following the several mutations of form, from that of the “Archimedes” and “Rattler,” to those of the “Rifleman” and “Teazer” and their congeners; and in watching in the instance of the “Dauntless” our complete return back again to that successful experience in the form of the original pair of Screw-ships from which we had allowed ourselves to depart. We have seen that the sole cause of that departure was induced, by an inconsistent requisition to continue in a totally distinct description of Ship an

exceptional and burthensome mode of armed appointment, which it was felt by our Constructors that a fine form of 'run' could not be made to bear; and we have learnt that the full form of 'run' which was thus, as it were, compelled to be substituted for it; though doubtless it might have borne the inappropriate burthen; yet was totally ineffective to carry it at a moderate speed, even when urged by the efforts of the most powerful machinery. This effect of a full form of after-body had indeed been always known in a general way; it had always been known that to 'fill out' either the 'entrance,' or the 'run,' of a fine-lined Ship, was by so much to injure her speed. But the actual extent of that injury was never before known. It was never before determined from actual and accurate experiment made in the same Ships; placed in every other respect under the same circumstances; what is the real difference in speed between a fine 'run' and a full one—What is the real difference of power required to equalize these different speeds—And what the real expense which the different speeds, due to these different forms, are certain to entail.

It is upon this point of view that the cases which I have specially quoted will, I believe, be found to furnish an experience of far higher moment than even that of vindicating the alteration of our Screw-ships; and it is alone for the sake of this experience that these things have been set forth. Because in the instances of one-half of the Engine-power of the "Rifleman;"—and four-fifths of the Engine-power of the "Teazer;"—and six-tenths of the Engine-power of the "Dauntless;"—and I might add the still higher proportion of the "Dwarf:"—All actually wasted and entirely lost; together with every attendant waste of stores and fuel, through a single point of malformation in only one of the extremities of these several Ships; we are presented with a combination of facts which seem to require more forcibly than any argument, that the 'filling out' of

and the serious effects of regulating the form and dimensions of our Screw-ships by the length of their Gun-slides.

'bows' and 'sterns,' for the special accommodation of any mere item of armament, should henceforth be abstained from. But if the peculiar difficulties under which the Paddle-steamer labours, do indeed require even an approach to such costly malformation of the extremities; then, the mode of armament which causes it, should at least be strictly confined to this exceptional case.

Certain it is that in the Screw-ship neither the difficulties of the Paddle-steamer, nor their consequences apply. Those who offered the Principle of the Screw as well as those who had authority to accept it, as a means of greatly increasing the Man-of-war value of our armed Steam-force, were both alive to these important distinctions. It was offered and accepted by both, because the guns might be removed to their more natural and general distribution over the broadside; and it was seen and intended by both, that this relief to the extremities, should admit of that finer form of design, which was alone looked to as the means of enabling the Screw-ship to exhibit a superior speed, when using the same power as the Paddle-vessel.

That these important distinctions were not seen and provided for, by all concerned, appears most clear; and the extent to which their oversight affects the whole history of the Screw makes it impossible with any regard to an honest consistency to have left the subject unnoticed. But specially so as the lesson taught by it extends far beyond the case which produced it; and bears such direct and hopeful testimony to the direct value of improvement in the form of our future designs; that the painfulness of tracing a transient and involuntary error to its source, may, I hope, be far more than compensated for by extensive and permanent advantages.

PART IV.

AN EXPLANATORY ILLUSTRATION.

I ONLY add that I am anxious no remark here made, should be interpreted into a desire to undervalue the use of the horizontal shell-gun of General Paixhans. On the contrary; as an invention admirably adapted for fulfilling its professed object of 'crippling' the British Navy; so is it admirably adapted for the use of the British Navy in meeting the attempt; and its employment upon the broadside, and even in the extremities of our Screw-ships themselves, is, I believe, not only desirable, but necessary. I will endeavour to explain myself thus. Let it be supposed that Ships of the same dimensions and forms as our Screw-ships have now been restored to,—taking, say, the "Encounter" as an example;—that such Ships had been introduced into the Navy for some needful purpose, prior to the days of Steam. In such case a complete and appropriate Sail-power would then have necessarily been their sole equipment for general service; and they would have been armed with a continuous battery of 12 or 14 of the most suitable guns of the day upon each broadside; extending from an aftermost pair of guns abaft the mizenmast, to a foremost pair of guns before the foremast. Thus equipped and armed, let me next suppose our Ship to have *passed through* the days of General Paixhans' invention; and that they have improved the character of her armament generally, and effected in it this special change; viz. The pair of guns before the foremast, and the pair of guns abaft the mizenmast, have each been taken away and replaced by a single shell-gun of larger calibre, and far more destructive effect than those removed; but so mounted that, like them, it is

The use of the pivot shell-gun perfectly consistent with the fine form and full Sail-power of the Screw-ship,

equally available for both broadsides; and still more available than they were, both for offence a-head, or defence astern; the weight of this single gun being the same, or nearly so, as that of the pair of guns which it superseded; and this same weight being sustained by the Ship in the same position as before. Now under these conditions it is clear that even the extremities of Ships of the same dimensions and delicate form as our present Screw-ships have now been restored to, are perfectly capable of being provided with the heavy pivot-shell-gun of General Paixhans; and that in order to do so it is neither necessary to tamper with their form either above or below the water, nor yet to meddle with their Sail-equipment. Thus agreed, let us now advance our case of supposition one stage further; and thus equipped with her original complete Sail-power, and with her modernized artillery, our fictitious "Encounter" having the same perfect Screw-ship form and dimensions as the real one, shall be brought down to the present time, and be subjected like her to the application of the Screw. The dead-wood of her 'run' will of course present the same fitness for being pierced so as to receive the Screw itself; the holds when cleared of their surplus stores, will of course present the same capacity for receiving the Engine of 360 Horse Power wherewith to drive it. And so soon as these are set to work upon the requisite shafting which connects the two; then the Steam-speed of the true and the fictitious "Encounter" will also of course be found to be the same.

as she was originally intended to be equipped.

And now that our supposed Ship, with her original full-spread Sails, has been brought to unite the days that were, in harmony with the days that be; preserving unimpaired her old traditional pride, enhanced by the consciousness of new powers both in armament and speed; what difference, I would ask, can be seen between our supposed "Encounter," and the real one? A very important difference, no doubt. Because the real

"Encounter" is not, yet, equipped with the complete and appropriate Sail-powers of a Sailing Ship of her rank like the supposed "Encounter;" and the real "Encounter" is not, yet, armed with the full and proud broadside of a Man-of-war of her rate and capacity like the supposed "Encounter." *But this difference is not a difference of necessity; it is only a question of time.* For the supposed ability of the fictitious "Encounter" for a complete Man-of-war equipment, has only been assumed from the real ability of the true one, when that ability is taken due advantage of. And whenever it shall be determined to furnish the true "Encounter" with the full Sail-power she is perfectly able to bear; and with the full armed broadside she is perfectly able to carry; then this Ship will furnish in her class, that example of the combined powers of Steam, Sail, and Armament, which all our full-powered Screw-ships were originally designed to exhibit. And the doubts and troubles which have so beset our progress, as yet, towards this desired consummation, will begin to disperse from the moment that we are presented with a first example, at once so simple and comprehensible to all.

CONCLUSION.

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FULL EQUIPMENTS THE ONLY SAFE AND REASONABLE TEST OF
THE VALUE OF THE SCREW-FLEET.

The extent and
cost of the
Screw-Fleet.

OF wood and of iron ;—of large and of small ;—built or building ;—converted, converting, or contemplated for conversion ;—the Force, which in these pages I have designated as a ‘Screw-Fleet,’ consists of forty ships.

Their respective measurements vary from the 164 tons of the “Dwarf,” to the 3074 tons of the “Agamemnon,” and give an aggregate of 49,157 tons.

Their respective engine-powers vary, from the 10 Horse-power (high pressure) of the “Teazer;” to the 780 Horse-power originally meant for the “Simoom;” and give an aggregate of 12,730 Horse-power.

Its value must
depend on its
services, and its
services must
depend on its
equipments.

This is, therefore, a very extensive force, and its cost has been, of course, in proportion to its extent. But its value, as compared with its cost, has yet to be determined by the character of its Services. And the value of its Services must evidently be determined by the extent of provision which can be made for them ; or, in other words, by the completeness of the equipment of the ships themselves. With respect to the Auxiliary portion of this force, which is principally composed of ships of war suitably converted for the Screw ; the question both of equipment, and of value of services to be returned, seems to admit already of a satisfactory solution ; and the “Plumper” and “Reynard,” as ‘Auxiliary Sloops;’ the “Amphion” and

The “Auxilia-
ries” give satis-
factory promise
of value;

"Arrogant," as 'Auxiliary Frigates' of their respective classes ; and the "Blenheim," "Hogue," and "Ajax," as 'Auxiliary ships of the line;' all afford proof that this portion of the force can be made to return a full value, in peace or war, as compensation for its cost.

In casting around for such ships as may enable us to form an estimate of the value of the 'Screw-ship;' or full-powered portion of this Force, it seems necessary to exclude the experience furnished by the "Rattler." Because she still possesses her original paddle engines of 178 tons weight ; and which are still, like other paddle engines, exposed to shot ; while 'Screw engines' of the same power have since been constructed of only 96 tons weight, and which are entirely protected. The greater weight of her engines thus absorbs displacement, which might otherwise go to complete her guns ; and the greater height of their centre of gravity, goes to deprive her of stability, which might otherwise enable her to complete her sails. So that, as regards the 'man-of-war' merits of the Screw-ship, as provided with full powers of equipment, the "Rattler's" experience can give no faithful evidence of her value. Neither may we look for conclusive evidence on this important point to either the "Minx," the "Teazer," the "Rifleman," the "Sharpshooter," or the "Phoenix ;" none of which are of a character to uphold even the 'man-of-war merits' of a Class ; much less to enable us to estimate the value of a Fleet, however important the information they have given us in other respects.

but no evidence is as yet afforded of the man-of-war value of the Screw-ship.

The late trials of the "Niger" went only to confirm in a still higher degree the previous speed-trials of the "Rattler;" but they were not of a nature to elicit the full capacities of the Screw-ship as a man-of-war ; and as a ship of 1072 tons with only fourteen guns, and furnished with a much smaller proportion of canvass than any sailing ship of the same rank, the "Niger," upon these trials, could only give satisfactory proof

that she was both worthy, and able, to be made the powerful Screw corvette which, at present, it cannot be said that she is. This also appears to be the extent of what can at present be said for either the "Encounter," or the "Conflict;" both of which are now in commission, and both of which will doubtless afford such experience of their value as their present equipments will permit. But partial equipments can evidently afford but partial evidence of such services as fuller equipments may be able to perform; and until we have the experience of such services as our Screw-ships are really able to effect, when equipped with the fullest appointments they are really able to bear; it seems evident that no just comparison can be made of the full value of these ships, as compared with their great cost.

Therefore future experience has yet to determine the true value of the "Screw-ship,"

If these remarks be just, then they lead to the conclusion, that, we possess a public Force, which, at the well known average prices of 25*l.* per ton; and 56*l.* per horse-power; will be found to represent, in hull, machinery, and equipment, a total expenditure of perhaps not less than two millions Sterling. And that with respect to the most costly portion of this Force,—and, therefore, the one from which we naturally expect the highest scale of Service;—we possess at present no more real experience, by which to determine its actual value, than we did in 1845, when first it was commenced. Every experience for such a purpose seems yet entirely future; and this circumstance seems at once the more valuable and important; because it allows time for this consideration; viz. That the proof of value, which experience has yet to supply; will evidently depend upon the mode in which that experience shall be ordered. For this appears to be one of those cases in which experience itself, if it be not a fitting experience, will only the more widely mislead. And the warning afforded by the total failure of the Screw under the ill-ordered experience of Liverpool; when contrasted with the entire success of the very same principle under the well-ordered experience of

and the value of that experience must be according as it is well or ill provided for.

London; may again be quoted as an instance which proves more forcibly than any argument, that the distinctive merits of the Principle itself require first to be clearly observed; and then, that the success which it is intended to realize from them should be appropriately provided for; or else experience itself cannot be referred to as a safe or a truthful evidence of value.

To explain myself more practically with reference to the immediate case I will again observe; that the holds of each of our Screw ships contain an engine intended to give effect to the fullest armament her capacity will enable her to carry; and that the after body of each is provided with the means of removing her propeller, so as to give effect to the full sail-power of a sailing ship of her rank. Both such preparations for success, having been made, as we are aware, with very great difficulty and expense. Nevertheless, let it be supposed, that full advantage should not be taken of these provisions. But that Screw sloops, which have cost as much as ordinary frigates;—Screw corvettes, which have cost as much as the largest ones;—and Screw frigates, for which the price of line-of-battle ships has been paid;—should each be sent forth for permanent Service, with equipments in guns and sails, far inferior to that of similar classes in the sailing fleet, and much below that which the real capacities of the ships themselves are equal to bear. How, let me ask, in such case could experience thus ordered, be quoted as a truthful test of the serviceable value of such ships; when such equipments would evidently provide for a scale of Services, very insufficient as a means to remunerate for their cost? Can the armed services of a sloop be performed by less than a sloop's guns? or the armed services of a corvette, by less than a corvette's guns? or those of a frigate, by less than a frigate's guns? Yet all our Screw ships may be taken to have cost, in round numbers, double the price of corresponding classes in the sailing fleet; and it seems, therefore, not unreasonable to expect that they should, if possible,

The experience to be expected in a supposed case of incomplete equipment.

be made to perform equal man-of-war Services as respects armament, at the least. I know that it is often said, 'Oh, the steam-power of these ships will give them great advantage when engaged with sailing ships.' Certainly; but this advantage is not of a nature to make one gun do the duty of two; neither can it make the fire of any gun more rapid or precise. The advantage of steam-power in these ships consists in the ability to bring a reluctant enemy to close action; and when engaged, to give great superiority over him in manœuvre; and surely this should be a reason for increasing the armament of such ships to the greatest extent we can. And especially so because their machinery has been provided, and placed in protection, for the sake of this very advantage; and because the extent of this advantage, is the only repayment we can look to for the expense of having provided it. Therefore it seems to follow that the more incomplete the armed equipment; the smaller the amount of advantage realized;—and the smaller the amount of advantage realized; the greater the amount of unredeemed cost. Nay, would the question be that of unredeemed cost alone?—might we not say, the more incomplete the armed equipment of these ships, the greater the risk of losing them altogether? Would the 22,000*l.* worth of machinery in the holds of the Screw corvettes; and the 32,000*l.* worth in the holds of the Screw frigates; which is like coined gold to any captors; be even adequately defended, by armaments far inferior numerically to that of the corvettes, and to that of the frigates, which these ships might respectively be opposed to? Might we not even carry our consequences still further; and believe that should the mishap of capture arise, in any case where such ships were not equipped to their fullest capacity, we should have to meet them, in an enemy's hands, with a far more formidable armament than that which they had received at our own?

The consequences of ill ordered expenditure

Now, if these arguments be good,—and if it be true that proportionally unredeemed cost, and an actual risk of entire loss,

must be the expected consequences of incomplete equipment in guns;—then it is yet more certain that increased cost, and real loss, must be the unavoidable consequences of incomplete equipment in sails. Because every yard of canvass which could be carried, and was withheld, would have to be compensated for by so many more tons of coal consumed. And the only experience which could be expected from any extended employment of our Screw ships, as supposed, with equipments inferior to their full capacities; would be precisely that experience which we are, of course, most desirous to avoid;—the experience of Liverpool. A full price would necessarily have been paid for a first equipment, however incomplete; and to this payment would have to be added the dissatisfaction attendant upon the inadequate Services which an incomplete equipment could alone return. Then would come dissatisfaction; and dissatisfaction would be aggravated by delayed success. And then alterations would be inevitable; and another full price would have to be paid for the full equipment, which would then take the place of the incomplete one. And all this accumulation of payments will have been incurred for the sake of that only advantage, by which it seems even possible that such a course should be recommended; viz. that of a supposed simplification of Equipment, by reducing the superior powers of our Screw-Fleet into some scale of classification, in common with the more limited powers of the ‘Steamer.’ And therefore in all such consequences as these, the Screw would be again,—not the cause, but the victim. The Screw would be as blameless of the expense, of these supposed alterations of Equipment; as it is now blameless of the expense, of past alterations of Form. Both would be the legitimate offspring of mistaking the Screw for some modification of the Paddle-wheel.

rience must result in a repetition of disappointment, alteration, and expense.

While so much experience is yet before us; may it not be well then to permit our supposed case to lead us a little further; and induce us to examine whether even the advantage of

The Screw is not a modification of the Paddle-wheel.

bringing these two descriptions of Ships under any common equipment, however varied in respect to scale, is in reality a practicable one.—Assuming of course, that Classification presupposes the assortment together of things similar,—not dissimilar? And with this clue to our search, it will not, I think, be difficult to show, upon very practical grounds; that a Screw, is not a Paddle-wheel; whether in the water, or out of the water, any more than a circular system of ‘Levers,’ is like an ‘Inclined Plane.’ They are two distinct mechanical Principles, each claiming its own distinct mode of operation in order to success—each distinct mode ruling certain conditions of application, as distinct as the Principles themselves; and such distinctions being no whit the less broad and sensible because it happens that both Principles are found capable of using the common motive-power of Steam; when both are employed in the common purposes of Propulsion. For instance; when the “Basilisk” and “Niger” were prepared for proceeding to trial, an official statement had to be transmitted of the state and circumstances of the two Ships. From which it appears that although they were, as intended, very closely alike in form, size, and dimensions; yet the hull of the Ship with the Screw, was 95 tons lighter than the hull of the Ship with the Lever. And this difference arose from this distinction; viz., that the shaft for driving a Screw, is situated in the lowest and strongest part of a Ship, which therefore requires no extra strengthening to enable it to sustain the effort; while the shaft for working a Lever is situated in the highest and weakest part of a Ship; which therefore requires a very great deal of extra strengthening to enable it to sustain the effort, combined, as it is, with the far greater weight of the Paddle-wheel itself.

An equally broad distinction was also found to exist between the Engines themselves, not alone in point of character, but again in point of weight. For those for the Screw were 54 tons lighter than those for the Lever, and again for the same reason as before; viz. that those for the Screw lay low and flat, without

any superstructure at all; while those for the Lever stand upright and lofty, involving a great deal of superstructure, which requires great strength, and involves great weight.* So that in preparing two Ships of the same size, and same form; provided with the same Steam-power, to be employed for the same purpose of Propulsion; (only the one driven by a 'Screw,' the other worked by a 'Lever') there is found to be a difference between their respective weights of Hull and Engines, amounting to 149 tons, or not less than one-tenth of the entire weight or load displacement of the Ships themselves. This difference being entirely governed by those distinct conditions, required by the two distinct mechanical Principles, by which they are respectively propelled. Nor does the distinction end even here; for great as is this difference in material saved, and in displacement gained, in favour of the Ship with the Screw; yet this difference is still more important, and gives rise to distinctions still more practical, when it is regarded as a difference in weights all situated above the water-line. That is to say, a difference of no less than 149 tons of 'top-weight,' in the two cases. In this respect it will at once be seen that the centres of gravity must assume an entirely different position in two such Ships; and therefore that every quality which is ruled by this important element in the character of all Ships, must also in effect be ruled, step by step, by those marked distinctions which separate the two Principles themselves. And so it proved practically to be. For although the Ship which used the Screw spread *less* plain sail, with a *greater* moment of inclination,—that is to say, a greater inclining power,—than that which was furnished to the Ship which used the Lever; yet the superior stability, and the far superior speed of the "Niger," were strikingly evinced in every sailing trial; and afforded ample

* I may here add that there was also a difference of not less than 10 ft. 10½ in. in the height of machinery in the two ships. The top of the engines for the Lever being 6 ft. 8 in. above the water-line; while the top of the engines for the Screw was 4 ft. 2½ in. below it; both ships being at their mean load draught of 15 ft. 11 in.

proof that the greatly superior disposition of every important weight, was working out its practical and natural effect, in a totally distinct character between the two Ships under canvass.

And the same distinctions which thus governed the practical working of the Sail-power, were seen to govern the practical working of the Steam-power also. For even the two elements of 'pressure of piston,' and 'speed of piston,' which together compose the power of every Steam-engine; require a distinct modification, according as the Engine is constructed to work a Lever, or to drive a Screw. The one requires a larger piston, with a longer stroke, and less revolutions; the other requires a shorter stroke, and more revolutions, and therefore admits of a smaller piston; and these distinctions, which also are entirely ruled by the differences in weight, and differences in mode of operation of the two mechanical Instruments; were practically exhibited most conspicuously during the most severe trials which took place; viz., when the two Ships were engaged in towing against each other, stern-to-stern. On that occasion there was a greater '*pressure*' used in the Engines working the Lever by an aggregate on the pistons of $6\frac{1}{2}$ tons; but there was more than double the '*speed of piston*' produced in the Engines working the Screw, even by so much smaller an aggregate '*pressure*;' and the greater difference in this element of power, enabled these latter Engines to exert a greater effort, by 188 horses. So that the practical result of the distinctions of Principle, thus extending to the character, as well as weight of the respective Engines, was seen in the fact,—that the Ship which used the Screw, dragged the Ship which used the Lever by the stern, against her utmost efforts, at the rate of $1\frac{1}{2}$ knots per hour nearly.

This essential distinction between the two Principles requires that Screw-Propulsion as adopted into the Navy

The broad difference which distinguishes the Principle of the Paddle, from the Principle of the Screw, is thus seen to extend, in full and practical force, to the Ships which respectively use them. It imposes upon them respectively a totally different amount and disposition in every important weight; it produces

between them a totally different character in speed, stability, and displacement; and in the severest services in which Steam-power is employed, it gives a marked superiority to the use of the latter instrument. These constitute the chief qualifications for Ships-of-war; and where these qualities are so fixedly distinct in two different descriptions of Ship as they are here shown practically to be; then, no common system, or scale of treatment, can be enforced upon both, which must not in the end be expected to produce Disappointment, Confusion, and Expense. But in order to strengthen these considerations of my plea, let me further add, that of the 12,730 Horse-power machinery now appropriated to the Screw; 11,782 Horse-power consists of Screw-engines alone. That is, of Engines constructed to lie horizontally on their sides, and drive a Screw-shaft placed many feet under the water; and which *cannot* be set vertically on end, and made to work a Paddle-shaft placed as many feet above the water. Moreover, this mass of machinery consists of THIRTEEN sorts of these Engines; all differing more or less from each other, in principle or detail;—almost all having been more or less subjected to trial, certainly; but none, excepting the auxiliary Engines of the “Amphion,” having been subjected to that extended proof for a period of commission, which can alone determine those respective merits by which to guide our future choice. So that we have on hand, I may say in round numbers, at this present moment, AT LEAST SIX HUNDRED AND SIXTY THOUSAND POUNDS’ WORTH OF ENGINES, which it is not practicable to use for any other purpose than that for which they were constructed. And with what degrees of merit they will respectively fulfil that purpose, is a point of very high importance which experience has yet entirely to decide. And when to this is added, that each full-powered Screw-ship in which these Engines shall be embarked, may then be made to receive a full equipment; and may then be made to exhibit in actual Service, in their several degrees, those distinct Man-of-war qualifications which

should be
treated upon
its own merits
alone.

were shown incipiently to exist in the trials between the "Basilisk" and "Niger;"—it may then perhaps be admitted, that the extent and importance of such a public Force as this, fully entitle it to have its value determined by an experience, ordered to the best of our ability, with an express view to elicit its own merits alone.

The distinct character of the "Niger" when only partially equipped as a "Steamer," or when fully equipped as a "Screw-ship."

Let me, then, reverse the picture, and endeavour to assist a future experience on which so much depends, by exhibiting what I conceive may be the real difficulties of providing each Screw-ship with the fullest equipment she can be made to bear; taking the "Niger" as our example.

The "Niger" is a Screw corvette, of 1072 tons in measurement, but of 1455 tons in real size or displacement; with a length of 194 feet between the perpendiculars. And the "Calypso" is a Sailing corvette, of 731 tons in measurement, but of 857 tons in real size or displacement; with a length of 120 feet between the perpendiculars.* So that the Screw corvette is larger than the Sailing corvette by 598 tons, or 69 per cent., and is 54 feet, or 45 per cent. longer; the cost of the two, when equipped for service, being in round numbers about 50,000*l.* for the Screw-ship, and 25,000*l.* for the Sailing one. The "Niger" upon her late trials was armed with a heavy pivot-gun at each extremity, with six guns on each broadside

* There is a difference of 383 tons, or 35 per cent. between 'tonnage' and 'displacement' in the "Niger," as a screw corvette; and a difference of 979 tons, or 67 per cent. between 'tonnage' and 'displacement' in the "Dauntless," as a screw frigate; while in the "Calypso," as a sailing corvette, the difference amounts to only 126 tons, or 17 per cent.; and in the "Thetis," as a sailing frigate, to only 361 tons, or 19 per cent.; the difference between these two measurements being always very much greater in a screw than in a sailing ship. This arises from the manner in which the very different proportions in length and breadth of the two descriptions of ship affect the calculation for 'tonnage.' And I notice it for the purpose of observing, that in most cases 'tonnage' gives a very erroneous impression of a screw-ship's real size, and, if relied upon, *may* lead to error in appointing her equipment. For unless displacement were referred to, it would hardly be known that in the instance of the "Dauntless" we have a ship which in reality is larger by 500 tons than any thirty-six gun frigate in the Navy.

between them. The "Calypso" upon her late commission was also armed with a heavy pivot-gun at each extremity, though on a separate platform, and with nine guns on each broadside between them. So that the Screw corvette, which is so much larger and longer, and has cost in round numbers 50 per cent. more than the Sailing corvette; was provided for a scale of armed services 30 per cent. inferior. Now, the question I propose to examine is this,—Is this great difference a matter of necessity, or is it not?—Is there any real difficulty which should prevent the "Niger's" greater size, and greater length, from being furnished to the definite amount of eleven, instead of six guns on each broadside, so as to bring the "Niger's" services, and the "Niger's" cost, to bear a closer proportion to each other?

The first difficulty, and not the least important one to deal with, would probably be stated thus:—'Oh! but you forget that the "Calypso" is a Sailing-ship, and the "Niger" is *only* a Steamer; and, as a Steamer, she is already very heavily armed; she carries fourteen guns, while her sister Paddle-vessel, the "Basilisk," of the same size and power, can only mount six.' Now, this is very true; the "Niger," with fourteen guns, is, undoubtedly, very heavily armed, *as a Steamer*,—far more so than many Paddle-vessels of far larger size. But if it be true that it is *only* under her designation 'as a Steamer,' and not according to her capacity "as a Ship," that the "Niger" is "*heavily armed*;" does not this very fact at once suggest that the "Niger" ought not to have been designated 'as a Steamer' at all? Does it not proclaim that any designation which can have the effect of precluding our ships from being armed according to their full capacities; is one which cannot be too soon abandoned, as being at once, most inappropriate and mischievous? A little reflection upon this point may lead us to remember that this word 'steamer' was first introduced into our language in order to describe a class of ship which has

The great injury and confusion which have attended the promiscuous use of the word "Steamer."

ever presented insuperable difficulties in the way of a complete equipment, whether in guns or sails. And after so many years of painful proof to this effect, it does appear to me to be little else than a misappropriation of language, to take this same word, and try to make it convey to us a true impression also, of another class of ship the very reverse :—one which presents no such difficulties at all ;—which does admit of a complete equipment in both guns and sails ; and not only this, but which we have adopted into the Navy, expressly because it offers to us these very advantages over the former one. Therefore, in so indiscriminate a use of one term, for two objects so distinct ; have we not placed in our own way perhaps the most serious stumbling-block which could have been devised, in order to impede the satisfactory solution of this whole question ; one which I am induced to think has contributed more largely than any other to embarrass it altogether ?

We are attempting to convey to ourselves a clear apprehension of that which we adopt because we know it to be *capable* ; and of that which we intend to supersede, because we have proved it to be *incapable* ;—by the use of one common term. When no common term in any civilized language, can thus be made faithfully to describe two opposite characters like these. And because, in allowing ourselves to make this strange attempt, the word “steamer” which we so promiscuously employ has but followed the law of all language—Because it has necessarily called forth the old associations of “incompleteness” with which it has ever been connected ;—and because it cannot call forth new associations of “completeness” which it has never yet been known to convey ;—therefore, we have been necessarily led by its accustomed influence to regard, and to treat, two opposite characters as if they were the same ; and the result of this confusion has been, first Disappointment, and then Distrust. Thus, an improvement of a most important and national character, has been regarded as if it were little or no improvement

at all; only, because it cannot possibly be the improvement which it was proposed to be, and which it really is, so long as it is thus placed under the ban of influences, which effectually prevent it from being treated as such. Thus, our own conduct has given birth to our own complaint; "that the screw has brought us as yet more trouble than advantage." Thus has there arisen a disposition to look on those who introduced it as at fault; and to regard those who support it with mistrust. And thus has it come to be doubted whether the Principle itself possesses any such merits as are attributed to it; when it is our mode of dealing with it, which has alone prevented these merits from being realized already. But let a designation which thus at the same time disparages and obstructs, be at once abandoned; and all these unfavourable influences may be expected at once to depart with it. For surely it cannot be a matter of doubtful choice whether we should abandon a disparaging and inappropriate word; or continue to disparage and keep in abeyance the powers of a whole Fleet for the sake of retaining it. No need for change with respect to the Paddle-vessel—it is her birth-right; let her be called a 'Steamer' still. But once let 'Screw-ship,' and 'Auxiliary,' designate the respective members of our Screw Fleet; and once let these terms be taken to denote a full capacity, for full powers of equipment in guns and sails, with similar classes in the Sailing Fleet; and a mist of doubt will be seen at once to clear up, as it were from before us; and this whole question will present itself for solution in a form at once simple, satisfactory, and hopeful, to a degree which it has never yet been permitted to assume.

If I have thus contributed to remove a first difficulty; I may be allowed with greater encouragement to proceed to the next. And in reply to the question, 'But does the "Niger" afford displacement enough for so large an increase to her guns?' I observe, that upon her late trials the "Niger" was actually weighted with one hundred tons of iron ballast, over and above

The "Niger" presents ample displacement for a full equipment.

the calculated weights of her present scale of equipment. But if one hundred tons of "available displacement" will not satisfy this difficulty; then I may state that certain of the trials of this Ship, were required to be repeated at several graduated stages of immersion, in order to test the effects of immersion upon her speed; and that no perceptible difference was produced on the "Niger," either in the effect of her Screw, or the power of her engines, whether she was light, or whether she was loaded, throughout a variation of two feet in her mean draught of water. I will only add that the height of her midship port-sills out of water at her load draught was 9 feet 6 inches; while those of the "Calypso" are only 5 feet 6 inches; and therefore no trivial increase of immersion, even if requisite, could in any way injure her in this respect.

The "Niger's" decks present ample space for full equipment if the space be well employed.

'But the decks of the "Niger" are too much surrendered to hatchways to admit of their being occupied by such an armament as she could carry.' True; but surely there cannot be a more cogent reason than this, for reducing their very extravagant extent. We find that the engines of the "Dauntless" are effectually ventilated by 140 square feet of hatchway area, and the "Niger's" engines, which are 180 Horse Power less, and one deck nearer to the air, can hardly require more hatchway area than this, in order to be equally well ventilated, if equal means be taken to do so. Therefore, the 580 square feet of hatchway which now prevents the "Niger" from being effectively armed, might with great confidence be curtailed by 440 feet of its present unnecessary extent, and thus make ample room for completing her to her full capacity as a Ship-of-War.

The "Niger" capable of receiving full equipment if her capacity be duly arranged for it.

'But the arrangements and supports of the "Niger's" decks and holds would have to be re-cast in order to provide for extended demands, if the "Niger" should be armed as fully as her capacity will admit.' Perhaps it may be so. But in so far as this shall be found requisite, whether in her case or in others, does not this constitute the

chief necessity of the whole case? If the "Niger" or any other of our Screw-ships be not effectively arranged for giving us the fullest services they can be made to render as Ships-of-war, is not this the very reason why they should be prepared for fulfilling this sole object of their construction? The decks of Ships employed in Mail Service are required to be arranged and supported, so that in case of need they may be taken for the purposes of war; and where compliance has been avoided or overlooked, care has been taken in many instances to enforce these terms of agreement. And does not the same motive apply with greater force still to the case of ships constructed for the purposes of war alone? May not the requirement be enforced with still stronger reason, if requisite, from these; seeing that full war Services are the only repayment we have to look to, for the expenses of a full war Cost? Surely in any such case as this, defective arrangement could never be pleaded as any reason for its continuance. Because this would not be to remedy the consequences of an oversight; it would be to prolong them, and to make them a continual, instead of only a temporary source of embarrassment, and expense.

'But then the Expense.' True. But in the view which I am endeavouring to give to the subject, the question of expense is involved,—not in giving to our Screw-ships the fullest equipments they can be made to carry; but it is involved in not doing so. The charge of expense would be involved in providing these ships for a scale of Services inferior to that which their real capacities might enable them to perform, and totally inadequate to their great cost. And it could never be urged against their equipment with the fullest powers they can be invested with. For instance, could the "Niger," even "heavily armed," 'as a Steamer,' upon her late trials, with 14 guns, be expected to maintain the character or afford the protection due from a British corvette of her size, in presence of foreign Ships of her own rank of 26 and 28 guns? Would not the "Niger," thus

Real expense involved in not preparing our Screw-ships for the fullest services of which they are respectively capable.

weakly armed as a ship of her real capacity and size, be reduced to maintain a doubtful struggle against the 20-gun sloop of other Navies? Nay, could such a struggle be expected to be even doubtful, if the "Niger," thus armed, were to be found with her machinery deranged, and only furnished with that inferior proportion of sail-power she is still provided with? But the "Niger," fully armed according to her capacity, with the assumed force of 24 guns, would be a totally different Ship from the "Niger" as engaged on her late trials. She would be a Ship fully prepared to maintain her character against any Ships of her rank, and, when fully furnished with canvass, would have little else to do than take the Sloop of any Navy in tow.

And surely such a change as this would be a change from loss to profit; and specially so as these ships must constitute in war or peace the chief protection to our commerce. Surely if charged as an expense, this change might be justified as a redemption; for redemption it would be, and one of no mean value too; and it would be just as defensible, and upon the very same grounds, as is the release of the 17,000*l.* worth of machinery now being redeemed to effective employment by the restoration of the form of the "Dauntless."

The superior form and qualities of the "Niger" have induced me to select her case for this instance of illustration. But neither her case nor that of others may be expected to present any real difficulty, which will not shrink into most manageable dimensions, before a settled intention to provide for our yet future experience, by appointing each of our Screw-ships, as they may come forward for employment, with the fullest powers they can be made respectively to carry; as the only means of making each of them repay their cost.

Deviations
from these ori-
ginal intentions
have only in-
volved past

I have already quoted the early provision of the 'Screw-engine' and the 'Lifting-gear,' by which alone this object of complete equipment could be fulfilled, as bearing silent but

conclusive evidence that it was our original intention to do so. And my own conviction is that first intentions are in this respect the best; that they are the soundest, the most promising, and the only easy ones to work out. Every deviation from them appears in degree to have only perplexed, and confused the whole subject, and occasioned the most painful portion of our past experience. And most of all has this effect been produced I believe by the unavoidable tendencies arising from the indiscriminate use of one common name for two Principles, which in every requisite condition, both Art and Nature proclaim to be distinct. Our only safe and reasonable course seems henceforth to avoid all self-imposed shackles induced by a supposed common classification; in which no element for common classification exists; and to direct our future steps towards the treatment of this subject, upon the basis of its own special merits. If it have no such merits, certainly it cannot be expected to acquire any, by a forced combination with another distinct Principle; and therefore to treat it as if it possessed them, must soonest discover the cheat. But if, on the other hand, the Screw be indeed a "Principle of improvement," then we can only expect to reap the reward of its advantages, by having a strict regard to their development alone.

difficulties and
threaten future
ones.

I have already shown that full Sail-power can be extended to every rank in our Screw-Fleet, upon the same Principles as govern its employment in our Sailing-ships. If these Principles should be thought worthy of being examined into, and should be ascertained to be sound; then it may not perhaps be too much to say, that their adoption would at once decide the question about 'Sail-equipment,' upon terms which are identical in Screw and Sailing Fleets alike. The Screw-sloop would then have the same proportion of Sail-power to her resistances, as we now give to the Sailing-sloop;—the Screw-corvette the same proportion as the Sailing-corvette;—and the Screw-frigate, as the Sailing one. And the merits of form would then alone

The proposal of
a definite and
comprehensive
System upon
which to organ-
ize our present
and future
Screw-Fleet.

decide the differences of Sail-speed, between the several classes in each Fleet.

So also the question of Armed Equipment will, I believe, find its most natural and easy solution by having recourse to the same sound basis for a system of permanence and order. And the germs of such a system, so soon as we begin to look for them, in earnest; may here be seen to spring up around us as we seek.

Thus, if we take, say the "Pilot" and "Espègle" to represent the 'Sailing-sloops;'—then we have the "Plumper," and "Reynard," as 'Auxiliary-sloops;' and the "Archer," "Wasp," and "Miranda," as 'Screw-sloops.' And we shall find that we are able at once to complete the class—'Sloops'—in its three several but connected ranks or orders, of 'Sloops' with Full Sail-power only;—'Sloops' with Full Sail-power, and limited Steam-power only;—and 'Sloops' with Full Sail-power, and Full Steam-power also.

So again, if we name the "Calypso" to stand for the 'Sailing-corvettes;' then we have the "Encounter," the "Niger," the "Conflict," and the "Desperate" as 'Screw-corvettes;'—the intermediate rank or order of 'Auxiliary-corvette,' remaining to be yet filled up. Unless, indeed, the great space occupied by machinery in the "Desperate," and "Conflict," should prevent these two Ships from being competently armed, except by replacing their present Full-powered Engines, by Auxiliary ones. In which case these two Ships would take position in the present vacant rank of 'Auxiliary-corvette,' and we should find that we are able at once to complete the class—'Corvette'—in its three several but connected ranks or orders also.

Again, if we take the "Thetis" to represent the 'Sailing-frigates' of 36 guns, then we have the "Amphion" as an 'Auxiliary-frigate;' and the "Termagant" and "Dauntless" as 'Screw-frigates.' And we shall find that we are able at

once to complete the class—'Frigate'—of 36 guns, in its three several but connected ranks or orders also.*

Lastly;—for it seems yet premature to bring in the Line-of-Battle-ships. If we take the "Leander" to stand for the 'Sailing-frigates' of 50 guns; then we have the "Arrogant" as an 'Auxiliary-frigate;' and we have the "Arrogant's" form and dimensions, from which to construct, with every confidence, our future 'Screw-frigates' of 50 or even 60 guns, whenever we choose to begin. And we shall find that we are able to complete the—'Frigate'—of our largest class, in its three several ranks or orders also.

Thus it may be seen that we already have before us a framework composed of our whole Screw Force. And that this framework but awaits the requisite time, and will, in order to be arranged into a Compact System, simple, comprehensive, and perfectly intelligible, to every rank, and every authority, afloat or ashore. Into a System which strictly follows out the guidance of first intentions; and conducts the Screw-ship into that natural position which her properties so evidently assign her;—by engrafting the powers of the Present day, upon the

* I am not aware, as I write, whether the "Termagant" can or cannot be made to carry more than her present appointment of twenty-four guns within the limits of her load displacement. But I am aware that the "Dauntless" is perfectly able to carry many more; and, therefore, if the "Termagant" be not able, then the "Termagant" must be regarded as an exceptional ship, and any idea of supposed sisterhood between her and the "Dauntless" may be regarded as untenable. For it would not be reason to disarm one ship of the guns which she is able to carry; for the mere purpose of likening her to another ship which is unable to carry hers. The "Dauntless" was designed from the first for a Screw-frigate of twenty-eight guns; 500 tons of displacement being at that time reserved for fuel; but, in completing her arrangements, it has been found practicable to stow but 350 tons; thereby releasing 150 tons of displacement for other equipment. Out of this overplus; 50 tons in round numbers are found to be absorbed by under-estimated weights of machinery. So that it is now ascertained, both by measurement and calculation, that there are one hundred tons of spare displacement within the limits of her load-draught available for increasing the armament of the "Dauntless." And it is further ascertained that this spare displacement will perfectly admit of the "Dauntless" being completed with thirty-six guns, extra stores, provisions, and all, if thought desirable.

time-honoured practice of the Past. We have thus in our power a System, which violates the integrity of no Principle, and gives offence to no honourable prejudice; but which harmonizes with the entire course of Naval education;—Naval discipline;—and Naval feeling. Which still reserves the reward of professional reputation, for skill in practical seamanship; and increases its value by enlarging its sphere,—in combination with the powers of Steam. A system which, in operation, provides full development for a Principle yet young; but regulates its several powers of Steam,—Sail,—and Armament; in successive stages of increase, based upon that long tried Experience, which it comes,—not to supplant, but to invigorate and prolong. In its effect, it would appoint to each new Construction, while yet under design; a distinct position to fulfil;—in a distinct rank or order; of one of those distinct classes, which would thus compose both Screw and Sailing Fleets combined. Thereby opening free scope for every extension, and improvement in the one as well as the other; but controlling that tendency to variety, which has subdivided our Paddle-Force, into almost as many classes as Ships. In respect to our present Screw-Fleet, it is a System which offers to provide a well-defined sphere of Service for each one of its members to perform; and would give renewed confidence and purpose in dealing with all of them. In providing each of our present Screw-ships for her appointed position, according to capacities and merits; proof would be furnished of cases to follow, and cases to shun. Every experience would find a fitting application to afford encouragement, or enforce warning;—and those who work, and those who direct, would find themselves mutually labouring upon one common and connected system; for one common and mutually understood object, of progressive advancement. Instead of her present hybrid prospects of being neither Sailing-ship nor Steamer;—unfurnished with the guns and sails of the one;—and unprovided for the Steam-en-

duration of the other; the Screw-ship would then be recognized in her own natural and intended character of combining the advantages of both. And a costly Force, which is now regarded with so much of anxiety, would then assume its true features of Form and Power, so as to remove all apprehension of a full remunerative Service for every portion of its Cost.

But I think I hear the whisper of Doubt again suggesting, ‘ If we do possess ships capable of being made to take rank in the several standard classes of men-of-war;—equal to them in merit as Sailing-ships;—and equal in armed force; but possessing additionally in security in their holds, independent powers of Steam, capable of use whenever wanted—Then unquestionably the natural System upon which to organize a Force like this, will be, as proposed, to engraft them upon the already established Classes of the Navy. But is the Screw-ship indeed the double-powered Ship which is thus described? Very good. Try whether she be so or not; and thus let there be no longer any doubt about it; for this question is surely too important to remain a subject of doubt any longer than is needful. We know not to what it yet may lead; but we do know the extent of Public property embarked in it already. But in providing for such a trial, it is essential that there should be no shrinking before difficulties which are not real; and that there should be no retention of any real difficulties, which are capable of removal. The Screw-ship will I believe be found to require no favour, if subjected to such a trial; but in common with every thing thus subjected to decisive test, it is necessary that she should have Fair-play. There should be a frank intention to try this question out in full, if at all; and to decide it, not by reasoning, but by sufficient and conclusive facts. The force of twenty-three ships commenced in 1845, has now increased to forty; and every full-powered Screw-ship then laid down, was then intended and believed to be able to fulfil the double-powered character I have described. As

A practical
appeal against
sceptical
doubts,

yet, however, this ability has been ascertained in no one single instance; neither as I write is there one single instance in which it can be said that a full-powered Screw-ship has been prepared;—or is being prepared;—with the view to ascertain it. There is no one single full-powered Screw-ship either prepared, or in course of being prepared, for an equipment with the full proportionate Sail-power of any similar classed Sailing-ship; together with the fullest armament of guns which she is capable of being made to carry. Many months of this last summer were occupied in Trials which were certainly very valuable, because they proved the superior propelling powers of the Screw, when applied under equally favourable circumstances, both in more ordinary Services and in Towing. But as regards the superior “man-of-war” powers which the Screw-ship may be capable to exhibit; these Trials were not of a nature to throw practical and conclusive light upon this part of the subject at all. Yet this was the PARAMOUNT purpose of the construction of them all; and according as they shall fail or succeed in fulfilling that purpose, so must their introduction be approved of or condemned. The question then yet waits for decision—“Can we, or can we not, combine in one ship, “effectively for every Service of Peace or War; Full powers of “sail; Full powers of steam, and a Full armament of guns?” And the decision of this question is not only all-important as affecting the purpose of our present Screw-ships; but it is difficult not to see that it is one which affects also every class of Ship, now under construction or design for the Navy, from at least our first-class frigates downwards. Other nations appear disposed to regard with more confidence than we do, the nature of this decision; and seem working out its Success with more apparent certainty of securing it. And should they succeed in showing that the Screw-ship is indeed the double-powered ship which I have described, and which she was always intended to be; then no sixty-gun, nor any other frigate, however nobly manned, or

well commanded;—if provided with Sail-power only, could evade an action with a ship of equal force, provided with Steam-power also; and that under circumstances of such disadvantage, as must almost ensure her capture. And in the case of such a struggle, there could be no resort to the ultimate effort to reduce inequality of circumstances by ‘boarding;’ because the power to ‘board;’ and the time to ‘board;’ must be entirely in the choice of the ship with Steam.

Might it not then be well to bring to issue a decision which so manifestly affects the whole character and mode of our maritime strength? And might not this decision be arrived at by the adoption of some such course as that with the terms of which I now bring this entire subject to a close?

by a direct proposal to test the services of the Screw-ship, with full equipment, as originally intended.

The services of the “Arrogant” fully elicited, in every important and practical circumstance, might confidently be taken to determine such portion of the question as regards the limited equipment with Steam-power of ‘Auxiliaries.’ But Full-powered Services, can only be performed by Full-powered Ships. And the value of our Screw-ships can therefore be determined, by the Services of our Screw-ships alone. Therefore might not some one favourable selection be made out of each of the two larger Classes of these ships, and the task of the decision be laid on these two vessels, after a full and fitting preparation for it?

If so, then, for the following reasons, the “Encounter” might perhaps be advantageously named to decide the man-of-war value of the Screw-corvette. Her plan of engines is tried, and is very promising; her general arrangements have been better cared-for than those of most, and would require least change. Her form, like that of the “Niger,” is unexceptionable. She is rather larger than the “Niger,” and within four feet as long; and, therefore, as was assumed in treating of the “Niger’s” case, she is equally as able to be pierced for eleven, instead of six guns on each broadside;—equally as able as the

“Niger,” to be made a powerful and effective Screw-corvette of Twenty-four guns. A very large portion of the “Encounter’s” holds is now surrendered to what is termed a ‘troop-deck;’ and if this waste space were restored to the holds whence it was taken; ample room might be found for the stowage of every increased store required by her increased guns; and for an increased supply of fuel to boot. The “Encounter’s” spread of canvass now amounts to but 11,270 feet; but there seems no reason why she might not be provided with the 14,500 feet of canvass, which corvette experience assigns as her right proportion; always having regard that its “moment of inclination,” or in other words, its inclining power, should be suited to her Stability of Form.

The “Dauntless” might be taken to decide the man-of-war value of the Screw-Frigate, perhaps for this general reason, that she is the most favourable ship for such a purpose, of the only two Screw-Frigates which at present we possess. I have already shown that she is capable of being equipped with a full armament of guns; and that she possesses displacement enough within the limits of her load-draught to admit of the requisite and accompanying increase in stores and provisions. And I have before shown in detail how she might be provided with the full spread of 21,000 feet of canvass, which Frigate experience assigns as her full proportion; and that it admits of being appointed with a “moment of inclination” completely adapted to her Stability of Form.

Thus equipped, both Ships might be permitted at first to prove, by themselves, the fitness of their appointments; and when found fit, then these appointments might be regarded as standard Establishments for each respective Class.

Thus fitly prepared, the Sailing merits of each might first be subjected to severe and decisive competition in all weathers with other Sailing-ships; and so soon as their true character in this important respect should have been satisfactorily esta-

blished, then there might be found for them some fitting Service which should elicit their qualities as ships of war, combining the double capacity of 'Sailing-ships' and 'Steamers.' In the performance of such service they might be kept (the harder the better) for a sufficient number of months to ensure indisputable proof of their powers. And then, from an exact registry of every duty performed; and every expense incurred in performing it; a final result might be arrived at perhaps in some such way as this.

The Services and expenses of each Ship under Sail only; might be compared with the Services and expenses of similar classed Sailing-ships.

The Services and expenses of each Ship under Steam only; might be compared with the Services and expenses of similar powered 'Steamers.'

The Services and expenses of each Ship under Sail only; might be compared with the Services and expenses under Sail only of similar powered 'Steamers.'

And lastly, the services and expenses of each Ship under the combined powers of Steam and Sail; might be compared with the Services and expenses of similar powered 'Steamers' when under these same combined powers also.

If comparisons such as these should be struck in each case for precisely similar periods; and, as near as practicable, gun for gun; force for force; power for power; then, I venture to submit that evidence of such a nature as this, might confidently be expected to decide, without further question, whether the Screw-ship can, or cannot fulfil her intended character as a full-armed British man-of-war, invested with Full and united powers, of Steam and Sail. Then, we should have gleaned an experience which might safely guide us through those extensive changes which the Screw, even now, is silently but surely working. And then all anxious doubt would finally be removed, as to whether so large an amount of Public property

has indeed been wisely embarked in securing the permanent and valuable improvements, held out by a new Principle; or whether it has been inconsiderately ventured on the mere modification of an old one.

I have now to close these pages with an act of grateful duty, in tendering my sincere acknowledgments to the many friends who so long and liberally have contributed to their chief value, by supplying the views and information they contain. I have ever pleaded for such information with the avowed object of turning it to public use, and now I have fulfilled my pledge.—With what advantage it must be for themselves and others to decide. But if I have assisted in giving a clearer view, or forming a juster estimate of a Principle which seems destined to effect afloat, what the Locomotive effects ashore;—a more rapid intercommunication of “Mail” and “Merchandise,”—not separate, but combined,—I shall not have to regret my many hours of anxious thought and labour thrown away.

